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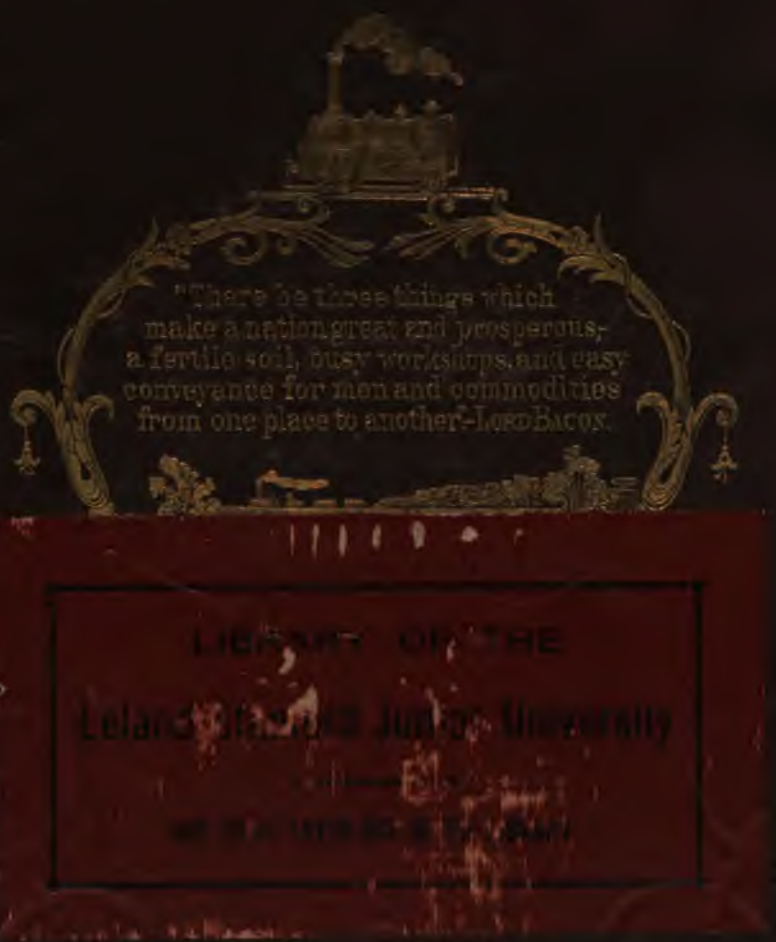
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a fertile soil, busy workshops, and easy
conveyance for men and commodities
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GAUGE EVIDENCE.

THE

HISTORY AND PROSPECTS

OF

THE RAILWAY SYSTEM,

ILLUSTRATED BY

THE EVIDENCE GIVEN BEFORE

The Gauge Commission.

BY

SAMUEL SIDNEY,

AUTHOR OF "BRISTOL A FREE PORT," ETC.

WITH A MAP.

"There be three things which make a nation great and prosperous,—a fertile soil, busy workshops, and easy conveyance for men and commodities from one place to another."—LORD BACON.

THIRD EDITION.

LONDON:

EDMONDS, 154, STRAND; AND VACHER, PARLIAMENT STREET.

1846.



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*** The evidence given by Messrs. A. Martin, Capt. W. O'Brien, and T. Whittaker, is omitted in this work.

RAILWAYS SANCTIONED BY PARLIAMENT IN THE SESSION 1845.

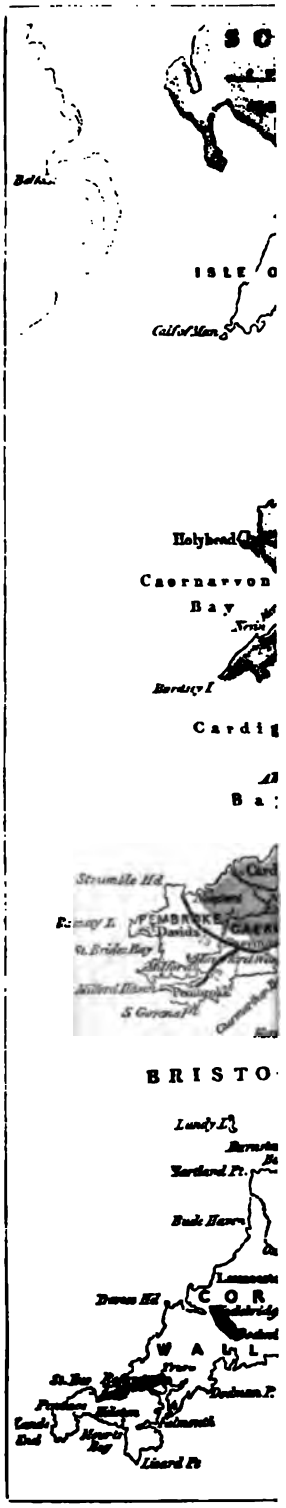
[The numbers prefixed to this List correspond with those on the Map.]

NARROW GAUGE LINES.

		Length. Miles.	Capital. £	Termini.	Termini.
0	Aberdare	8½	50,000	Taff Vale Line near Ynys	Aberdare.
1	Ashton, Stalybridge and Liverpool Junction—Ardwick	1¾	60,000	Ashton, Stalybridge & Liverpool Line, in Newton	Manchester and Birmingham Line, in Ardwick.
2	Bedford, London and Birmingham	15m. 74c.	125,000	London and Birmingham Line, near Bletchley	Bedford.
4	Birmingham and Gloucester—Gloucester Extensions, Stoke Branch, and Midland Junction	1⅞	27,422	Birmingham and Gloucester Line	Gloucester and Berkeley Canal and Basin—Stoke Prior, Birmingham and Gloucester Station, at Aston.
5	Blackburn, Burnley, Accrington and Colne	24	530,000	East Lancashire Line	Blackburn, Burnley, Accrington and Colne.
6	Blackburn, Darwen and Bolton	14½	300,000	Blackburn	Bolton.
7	Blackburn and Preston	3¾	52,468	Blackburn and Preston Line, in Blackburn	Blackburn, Burnley and Colne Line, in Blackburn.
9	Brighton and Chichester—Portsmouth Extension	22⅜	320,000	Brighton and Chichester Lines	Portsmouth, London and South-Western, at Fareham.
10	Brighton, Lewes and Hastings—Hastings, Rye, &c.	29m. 61c.	500,000	Hastings	Ashford.
11	Keymer	9117	140,000	Brighton, Lewes and Hastings Line, from Southover, Lewes	London and Brighton Line, at Keymer.
13	Chester and Birkenhead Extension	718	300,000	Grange Lane	Grange End.
14	Chester and Holyhead	4½	500,000	Chester	Holyhead.
15	Cockermouth and Workington	8½	80,000	Cockermouth	Whitehaven and Maryport Line, at Workington Harbour.
16	Dunstable, London and Birmingham	7	50,000	London and Birmingham Line	Dunstable.
17	Eastern Counties—Ely and Whittlesea Deviation	23⅜	330,000		
18	,, ,, Cambridge and Huntingdon	17⅛	150,000	Eastern Counties, at Chesterton, Cambridgeshire	Huntingdon.
19	Eastern Union		50,000	Colchester	Ipswich.
20	Eastern Union and Bury St. Edmunds, No. 2	26¾	400,000	Eastern Union Line, at Ipswich	Bury St. Edmunds.
21	Ely and Huntingdon	22½	194,400	Ely	Huntingdon.
22	Epping, No. 2	1¾	200,000	London and Blackwall Line	Eastern Counties Line.
23	Erewash Valley	13¾	190,000	Midland, at Sawley, Derbyshire	Mansfield and Pinxton Line, at Selston, Notts.
25	Gravesend and Rochester	6¼	170,000	Gravesend	Rochester.
26	Great Grimsby and Sheffield	59½	600,000	Bale, near Gainsborough	Great Grimsby.
27	Great North of England—Clarence and Hartlepool	23 ch.	21,000	Great North of England—Clarence and Hartlepool Line, in Trislington	Newcastle and Darlington Junction, at Ferryhill.
28	Great North of England and Richmond	9¾	150,000	Great North of England Line	Richmond.
29	Guildford Junction (sold to South-Western)		855,000		
30	Huddersfield and Manchester Railway and Canal	22¼	630,000	Sheffield and Manchester Line, at Stalybridge	Manchester and Leeds, at Kirkheaton.
31	Huddersfield and Sheffield	15½	532,000	Huddersfield	Sheffield and Manchester Line, at Penistone.
32	Hull and Selby—Bridlington Branch	31	216,600	Hull and Selby Line	Bridlington.
33	Kendal and Windermere	10½	125,000	Lancaster and Carlisle Line	Birthwaite.
34	Lancaster and Carlisle Deviation	4½	,,	Lancaster and Carlisle Line, at Upperby	Newcastle and Carlisle Line, in Carlisle.
35	Leeds and Bradford—Shipley to Colne	31	500,000	Leeds and Bradford Line, at Shipley	Colne.
36	Leeds, Dewsbury and Manchester	20½	650,000	Leeds and Bradford Line, in Holbeck	Huddersfield; also Manchester and Leeds Line, at Kirkheaton.
37	Leeds and Thirsk	44¾	890,000	Leeds	Castle Field, Thirsk, or by Junction with Great North of England.
38	Liverpool and Bury—Bolton, Wigan and Liverpool and Bury Extension	33¼	912,000	Liverpool	Bury.

39	Liverpool and Manchester Extensions	7¾	805,000	Liverpool and Manchester Line, at West Derby or Wavertree.	Waterloo-road, Liverpool.
				Barton-upon-Irwell	Manchester, Bury and Rossendale Line, at Clifton.
40	London and Brighton—Horsham	8¾	100,000	London and Brighton, Three Bridges Station	Horsham.
41	London and South-Western—Metrop. Extension	2	800,000	Nine Elms Terminus	A point near Waterloo and Hungerford Bridges.
42	Lowestoft Harbour and Railway	11¼	120,000	Lowestoft	Yarmouth and Norwich Line, at Reedham.
43	Lynn and Dereham	26¾	270,000	Lynn	East Dereham.
44	Lynn and Ely	37¾	300,000	Lynn	Ely.
45	Manchester and Birmingham—Ashton Branch	5⅓	93,000	Manchester and Birmingham Line, at Heaton Norris	Sheffield and Manchester Line, near Guide Bridge.
46	Manchester, Bury and Rossendale		,,	Manchester and Bolton Line, at Eccles	Whalley.
47	Manchester and Leeds—Burnley Branch	8⅛	360,000	Manchester and Leeds Line, at Todmorden	Burnley.
48	,, Heywood Branch	4		,, ,, Heywood	Bury.
49	,, Oldham	1½		,, ,, Oldham	Mumps.
50	Manchester, South Junction and Altrincham	9½	400,000	Manchester and Birmingham and Liverpool and Manchester Lines, at Manchester.	Altrincham.
51	Middlesborough and Redcar	7¾	36,000	Middlesborough	Redcar.
52	Midland—Nottingham and Lincoln	33¾	408,000	Midland, at Nottingham	Lincoln.
53	,, Syston to Peterborough	47¾	750,000	Midland Line, at Syston	Peterborough.
55	Newcastle and Berwick	90¼	1,400,000	Newcastle-upon-Tyne	Berwick-upon-Tweed.
56	Newcastle and Darlington—Brandling Junction	6	650,000	Brandling Junction	Monk Wearmouth and Durham Junction Line.
57	Newcastle and North Shields—Tynemouth Extension	1½	50,000	North Shields	Tynemouth; New Quay, Newcastle.
58	Newport and Pontypool	13	119,100	Newport	Pontypool.
59	North Union and Ribble Navigation	64c.7y.	16,000	North Union Line	Victoria Quay, Preston.
60	North Wales Mineral	12½	150,000	North Wales Mineral Line	Ruabon.
61	North Wales, Porthdynllaen and Bangor	28¾	300,000	Porthdynllaen	Bangor.
62	North Woolwich	2¾	30,000	Eastern Counties Lines, near the mouth of the Lea	North Woolwich.
63	Norwich and Brandon Deviation—Diss and Dereham Branch	17	220,000	Norwich and Brandon Line	Diss and East Dereham.
66	Preston and Wyre Branches	8½	50,600	Preston and Wyre Line	Blackpool, Lytham and Lytham Docks.
67	Richmond (Surrey)	6	260,000	South-Western, at Battersea	Richmond.
68	Sheffield and Rotherham	3 fur. 2c.	45,000	Sheffield and Rotherham Line	Sheffield and Manchester Line, in Brightside, Burlow Sheffield.
69	Shrewsbury, Oswestry and Chester Junction	23¾	410,000	Shrewsbury	Cefn Mawr, Ruabon.
70	Southampton and Dorchester	62	500,000	Southampton	Dorchester and Poole.
71	South-Eastern Extension to Deal, Canterbury, Margate and Ramsgate	9½	187,000	Canterbury, Ramsgate and Margate Branch of South-Eastern Line.	Deal.
72	South-Eastern—Tunbridge to Tunbridge Wells		,,	South-Eastern Line, at Tunbridge	Tunbridge Wells.
74	Taw Vale		,,	Penhill, Devonshire	Barnstaple.
75	Trent Valley	49¼	1,250,000	London and Birmingham Line, at Rugby	Grand Junction, at Stafford.
76	Wakefield, Pontefract and Goole	27¾	365,000	Manchester and Leeds Line, at Wakefield	Pontefract and Goole.
77	Wear Valley	11¾	82,000	Crook Branch of the Bishop Auckland and Weardale Line.	Watchlas Hill, Frosterley.
78	West London	1¾	60,000	West London, at Kensington	A point near Battersea Bridge.
79	Whitby and Pickering (sold to York and North Midland)				
80	Whitehaven and Furness	40	350,000	Whitehaven	Furness Line, in Dalton.
82	York and North Midland—Bridlington	19¾	87,000	York and Scarborough Line, in Seamer	Bridlington.
83	,, ,, Harrogate	18	220,000	York and North Midland Line, in Church Fenton	Bilton with Harrogate.
84	York and Scarborough Deviation	3	38,250	York and North Midland Line, midway between Holdgate-lane Bridge and Engine-house of York and North Midland Company.	York and Scarborough Line, in Huntingdon.
		Miles 1,290	21,736,640		

OCCUPIED BY


Caernarvon
Bay
Cardig
Strumble Hd
PEMBROKE
Milford Haven
BRISTO
Lundy I.
Hartland Pt.
Bude Haven
Dover Hd
C O R
W A L L
Lizard Pt

INTRODUCTORY CHAPTER.

A BRIEF HISTORY OF THE GAUGE QUESTION.

"We owe all our railways to the collieries in the North; and the difficulties which their industry overcame taught us to make railways, and to make locomotives to work them."* In the rude tram-ways which frequently intersect the high road in every coal district, we see the origin of that gigantic system of internal commerce which has more than any other modern invention contributed to develope the mineral and manufacturing resources of this country. Its effect on agriculture has as yet scarcely been so potent. In a few years we may expect to see throughout the world the current of trade flowing along those ancient channels which became disused centuries ago in favour of the then cheaper and swifter marine navigation.

Railroads may be said, in the truest sense of the word, to have grown gradually, although rapidly, to their present magnificent proportions. Introduced in the first instance in order to lessen the labour and

* Captain Law's Evidence, p. 234, *Post.*

increase the power of horses employed in drawing coals from the pit mouth to the point of sale* or embarkation, each line of road was naturally constructed in such a manner as to best suit the nature of the country it was intended to traverse, and the nature of the load it was intended to bear. Thus railroads, unlike many admirable inventions, instead of being adapted to practical use from a scientific theory, worked out by a series of closet experiments, are the result of the daily labours of generations of obscure, industrious, ingenious men, only intent on conveying from the mine to the river the largest quantity of coal at the least possible expenditure of time and money. The coal miners of the North execute extraordinary works, but they write very few books.

It was with all the advantage of this experience that the first railroad traversed by locomotives was constructed, and not on any purely theoretical or empirical principle; and to this circumstance we may attribute the fact that, with few exceptions (The Great Western Railway and its Branches), the railroads throughout the world have, in the main, been constructed on the same principles as the model line between Liverpool and Manchester, from the opening of which, dates the commencement of the railroad system as a science.

The first attempts to apply the power of steam to land locomotion were directed to common roads, and these attempts have even yet been scarcely abandoned.

* "The manner of the carriage (*of coal*) is by laying rails of timber from the colliery to the river, exactly straight and parallel; and bulky carts are made with four rollers fitting those rails, whereby the carriage is so easy that one horse will draw down four or five chaldrons of coals, and is an immense benefit to the coal merchant." —Life of Lord Keeper North, A.D. 1676.

Those who turned their attention to the tram-ways, wasted much excellent ingenuity in striving to overcome a purely imaginary evil. They fancied that cog wheels or propellers were required to enable a locomotive to ascend such acclivities as it would be necessary to encounter in a tram-way of any length.

While this mechanical problem was as yet unsettled, the merchants and manufacturers of Liverpool and Manchester began to consider the possibility of availing themselves, for the transport of raw and manufactured goods between those two great towns, of those means of transport which had been found so useful in the coal tracts of Northumberland and Durham. They did not at first contemplate anything more than a solidly constructed tram-way to be worked by horse power.

Fortunately they placed the execution of their project under the direction of George Stephenson, at that time one of the most eminent of the colliery engineers;—a man whose mechanical genius is of that order that it may, without exaggeration, be asserted, that if Watt had not previously invented the steam engine, he was capable of achieving it. Born in the humblest rank of life, self-educated, endowed with an industry, energy, and indomitable perseverance, which rendered his manifold and eminently practical abilities fully available to his employers, he early obtained an independent position, and a high reputation in his profession; but he might have lived and died unknown beyond the district of his earlier labours, had it not been his well-deserved good fortune to commence and complete a work which, in extent, grandeur, and utility, rivals even those roads and aqueducts which, after withstanding for centuries the attacks of time and barba-

rism, still testify the power and wisdom of ancient Rome.

Others before him prepared the way; others since have contributed valuable improvements in detail; but to George Stephenson unquestionably belongs the proud title of the Author of the Railway System. He gathered the many threads of ingenuity, and enterprise, and weaved them into the wide-spreading network which promises, in its manifold extension, to envelope the whole world in bonds of commerce, civilization, and peace. But with all his far-seeing genius, and all his talents, he does not possess those minor arts which contribute not a little to secure cotemporary, in addition to posthumous, applause; arts by which lesser men keep themselves constantly before the eyes of an admiring audience, and secure constantly re-echoing applause for conquering difficulties by themselves created.

Before the Liverpool and Manchester line was completed, George Stephenson, who had discovered that carriages driven by steam were capable of surmounting gradients of considerable altitude by the force of their weight alone, proposed to employ locomotive instead of horse power for the merchandize and passenger traffic. The Gauge or width between the rails adopted on this line was 4 feet 8½ inches, or what has since been generally designated the Narrow Gauge, and was the dimension which had been found most suited to the general requirements of the mineral traffic, as well as exceeding in width to the broadest road vehicle in use in this country.*

* The width of an ordinary Narrow Gauge goods waggon is from seven feet to seven feet six inches. The length depends upon the nature of the traffic, but not unfrequently exceeds thirteen feet.

The proposition for the use of steam power excited the alarm of a great number of the shareholders. At the request of the dissentients, two eminent engineers, the one engaged on Government works, and the other in the manufacture of steam engines, investigated the subject; and, in "a very able document," proved most clearly that Mr. Stephenson's project was, practically and commercially, inexpedient.

This report was triumphantly answered by George Stephenson's two pupils, his son Robert, and Joseph Locke. Genius and enterprise prevailed. The horse plan was abandoned. The most ingenious mechanics of the day applied themselves to the construction of locomotives, in order to contend for a prize of 500*l.* offered by the directors of the Liverpool and Manchester Railway, and on the 15th September in the memorable year 1830, engines from the workshops of the Stephensons, Braithwaite, and a third, Rothwell, in the sight of assembled thousands, resolved the railway problem.

The successful application of steam to railway conveyance, at high rates of speed, at first caused passenger traffic to supersede, in a great degree, the objects for which the Manchester Railway was originally planned, viz., the carriage of merchandize; and an opinion became prevalent, which has only been dissipated within the last few years, that railways could, under no circumstances, profitably contend with canals for the conveyance of heavy freights. The carriage of coal at 1*d.* per mile per ton would then have been treated as a Utopian vision.

The railways constructed in consequence of the success of the Liverpool and Manchester line were for the most part planned by Stephenson and his pupils; and as one of the principles with which he started was the

importance of a uniformity which would permit the freest intercommunication, they were all laid down on the same Gauge.

Thus while others were declaring that railroads would only be effective for passenger traffic, just as they had previously declared that locomotives would not move, and that locomotives would not pay, Stephenson foresaw and foretold the universality of utility which the iron-road system has since attained, and prepared those under his control for the eventual receipt of traffic from the cross roads and bye roads, as well as the main roads of the kingdom.

A history, as interesting and extraordinary as a romance, might be written of the difficulties encountered and conquered by the early projectors of railways. Nothing less than golden arguments of the purest mint would induce noble and gentle landholders to give assent to roads which trebled their estates in value; and vast loss of money and of time was incurred in making those circuits which now excite our wonder and regret, in order to allay the fears of cities, lest conflagration—and universities, lest contamination—should attend the near approach of steam power; but such a history does not fall within the limits of this sketch.

Soon after the Liverpool and Manchester railway was opened, it was found that the width of the Gauge, according to the then construction of engines, did not afford sufficient space for cleaning and repairing, and it became a favourite idea with many engine-builders, that a few additional inches to the Gauge would increase the power and in every way much improve the locomotive; others, considering that all railways must eventually communicate, applied themselves to simplifying the

engine and adapting it to the Gauge;—and even up to the present day, the question is, *shall the engine be adapted to the Gauge, or the Gauge to the engine?*

In 1833 the Great Western Railway was projected. According to the original plan, it was to have departed from the London and Birmingham station, and been constructed on the same Gauge. The first Bill was thrown out by the ill-judged opposition of the authorities of Eton School, Oxford University, and other landowners on the proposed line, who have often since long and deeply regretted their ill-judged and ignorant resistance.

Pending the renewal of the Parliamentary contest, Mr. Brunel, to whom the engineering department had been confided, conceived and communicated to the Directors his idea of increasing the hitherto universally adopted Gauge by 2 feet 3½ inches, in all to 7 feet; that is to say, to what is now universally known as the Broad Gauge. The plan, with Mr. Brunel's reasons for proposing the change, was submitted by the London and Birmingham Directors to their engineer, Mr. Robert Stephenson. He reported against it, and consequently the arrangement for a joint or close adjoining station was abandoned. A conclusion which must always be deeply regretted, as nothing could possibly add more to the convenience of travellers and carriers than the close approximation of all metropolitan termini.

With his own Directors, Mr. Brunel was more successful, and thenceforth he became the observed of all observers. No longer following in the track of the Stephensons, he rose, from the crowd of engineers, in the eyes of his admirers, to the rank of an original

inventor, and hoped to imperishably connect his name with a new system.

It must be confessed that in the vast dimensions of Brunel's system, its Titanic arches, its Acherontian tunnels, its Cyclopean engines, and in its apparent capacity to convey whole armies at one effort, there was something well calculated to fascinate alike the imagination of speculators, still vaguely calculating the ultimate pecuniary results of the new power, and of those not uninfluential patrons of art and public works, who tired of the stuccoe fripperies of the Georgian era, found to their delight and amazement, architectural grandeur combined with utility.

The Great Western Railway, too, was undertaken on, in some degree, different principles from those previously executed between London and the North. It was intended rather to develope and create, than to supply the demands of already existent and overflowing traffic, such as that between Liverpool and Manchester, and London and Birmingham. The chief promoters took up the scheme with more of the spirit of provincial patriotism than of common-place speculation; and such parties are generally anxious to distinguish themselves by the execution of some remarkable monument of their munificence. Mr. Brunel's scheme promised an opportunity of patronizing genius, executing magnificent works, and realizing enormous profits.

In the reports laid before the Great Western Directors for the purpose of explaining, and inducing them to adopt the Broad Gauge, Mr. Brunel laid down certain general principles on which he justified his deviation from that Gauge which had hitherto been universally adopted. He assumed that England and

Scotland would be divided into railway districts—a sort of Railway Heptarchy—over which each separate Company would reign supreme—that between these districts, if judiciously laid out, there would need be but little communication. Break of Gauge in a continuous line of traffic he *then* considered a great evil; but like many others, he only anticipated a few great railroads between a few great towns. He concluded, therefore, that each Company might with advantage adopt such form of construction as should be found most suitable to the district traversed and the traffic to be supplied. For instance, in a mineral district, where the gradients are almost invariably difficult and the curves sharp, he recommended, and has adopted a Narrow Gauge, but on the Great Western, where he anticipated a large passenger traffic, and in comparison with the northern lines but little mineral or merchandize, he thought that it would prove in the end most economical to prepare for high speed, by a great expenditure in rendering the line as nearly level and as nearly straight as possible — and for armies of travellers, all moving at one time, by very wide carriages. He further proposed to ensure speed by making use of high wheels, and safety by placing the bodies of the passenger carriages within instead of upon the wheels. He also pointed out that by adopting his propositions the supply of railroad conveyance for the West of England and South Wales would be for ever retained in the hands of the Great Western Company.

Mr. Brunel's reasoning prevailed, his gigantic scheme was adopted. It would have been strange if it had not, considering its theoretical plausibility and the well known persuasive abilities of its author.

The Bill was obtained, and the road was commenced; but before it was finished some of the shareholders became alarmed at the enormous expense, and the numerous experiments which their engineer was engaged in trying. The first plan on which the timbers of the road were laid proved an entire failure, and had to be all relaid, and a bridge built over the Thames at Maidenhead, to show how the river might be crossed by two arches, while the old bridge close by required not less than six, fell down twice. It was again rebuilt, and stands a monument of what an engineer of genius can effect with shareholders' money.

Accordingly, the dissatisfied shareholders applied to Mr. Robert Stephenson to examine and report on the new Gauge. He declined, on the ground that it was already well known that his opinion was unfavourable. Mr. Nicholas Wood, of Newcastle-on-Tyne, and Mr. Hawkshaw, at the request of the same parties, investigated the question most elaborately, and reported against it. But the majority of the shareholders, remembering perhaps that a great government engineer had also reported against using locomotives on the Liverpool and Manchester Railway, decided on supporting Mr. Brunel, and giving his system a fair trial.

After many mishaps, many difficulties, in obtaining engines which would work—the first, which were made with huge wheels, having been found totally useless, almost impossible to put in motion, and when in motion almost impossible to stop, the Great Western Railway was fairly opened; and achieved, in theatrical phrase, a great success. The carriages—that is to say, the first-class carriages—were luxuriously roomy and airy. The breadth of Gauge admitted the

construction of a conveyance for her Majesty truly royal; the road was smooth and the pace was swift, and, with exception of professional criticisms from engineers, who remarked that the ten-feet engine driving wheels, from which such speed was expected, had been abandoned, and that the passenger carriages were, like those of the Narrow Gauge, placed upon instead of within the wheels, according to the original Broad Gauge plan; with exception of these criticisms, in which the travelling multitude took no interest, the comparison of the two Gauges ceased to occupy the public mind.

While the Broad Gauge was still a matter of discussion, the Eastern Counties line was commenced, under the superintendence of Mr. Braithwaite, whose firm, as before mentioned, were candidates for the locomotive prize on the opening of the Liverpool and Manchester Railway. The propriety of adopting the Broad Gauge was discussed; eventually, a Gauge of 5 feet was adopted, on the recommendation of Mr. Braithwaite, who found, from actual admeasurement of the engines he was constructing, that $3\frac{1}{4}$ inches of width would give all the additional space he required.

In Scotland and in Ireland, Gauges intermediate between the Narrow and the Broad have been constructed; but in the former all the principal lines have been or are about to be reduced to the prevailing Gauge, while to the latter it is unnecessary, for the purposes of the present sketch, to refer.

When the Northern and Eastern, an extension of the Eastern Counties was made, the engineer, Mr. Robert Stephenson, in order to secure the uniformity which he, like his father, considered one of the most important principles in the railway system, laid it down

on the 5 feet Gauge, and thus was avoided an opportunity of producing what has since occasioned so much sensation and discussion in the mercantile and railway world—a Break of Gauge.

After an interval of some years, during which, according to the evidence of Mr. Braithwaite and other eminent engineers and engine-builders, improvements in the construction of engines, especially the adoption of outside cylinders, had quite superseded the necessity for the additional 3½ inches of width for which he had formerly been anxious,* an extension of the Midland Counties brought a Narrow Gauge line in contact with the Eastern and Northern, and Eastern lines; and in order to obtain uniformity, both were reduced to the original Gauge of 4 feet 8½ inches, Mr. Braithwaite fully concurring in the propriety of the step.

So long as the two systems remained apart, and the public had neither the means of comparing the effects of the two Gauges upon fares, nor of enduring inconvenience from their contact, all went well. While the whole invention was a novelty, travellers were too much pleased with the change from the expenses of posting and the fatigues of coaching, to criticize or scrutinize the merits of the new system. Shareholders were silent for their own sakes, right or wrong; a railway could not be altered with the same ease that a coach-master disposed of an incurable kicker or gibber.

* "Barring those little notions we had about the addition of 3½ inches, which the improvement of the locomotive has quite superseded, I think for the purposes of passengers in particular, the Narrow Gauge is infinitely superior to any other."—*Mr. Braithwaite's evidence.*

In June, 1844, the Bristol and Gloucester Railway, which, although originally projected on the Narrow Gauge, as an extension of the Birmingham and Gloucester, had by a financial *coup de main*, fallen virtually under the influence of the Great Western Company, and been laid down on the Broad Gauge, was opened; the two systems met, and the BREAK OF GAUGE began.

It was soon found that merchandize did not flow so smoothly and continuously over this route as over the Grand Junction, the London and Birmingham, the Midlands and other lines, where no interruption of Gauge occurred. Passengers walked across the platform with all their small baggage, in order to change from Broad to Narrow, from four abreast carriages to three abreast carriages, and *vice versa*. This was unpleasant in the night time, and in cold weather, and highly inconvenient to mothers with families, to the lame, the halt, and the blind. But as this was an inconvenience to which travellers had been accustomed, although without any necessity, at Birmingham, through the feuds and defective arrangements of the London and Birmingham and Grand Junction Companies (since amalgamated); and as the mothers, the lame, the halt, the blind, are not only unfrequent travellers, but very powerless in agitating, if the evil had been confined to them it might have long remained unredressed. The same may be said of the Cork pig drivers, and the drovers in charge of Devonshire oxen for the Midland markets, who experienced still more difficulty and delay with their charges; for Paddy is patient in England, and grateful for not trudging through the mud; and the agricultural mind is notoriously slow to be aroused to any novel

exertion. But among the other parties displeased by the unpacking and repacking incident to the change of Gauge, were the merchants and manufacturers of Birmingham—a town famed for its taste for grievances and public meetings. When they found packages intended for shipment at Bristol delayed and mislaid at Gloucester, and the space between their factories and the ports of the Bristol Channel as difficult of transit as when they had to rely on the uncertainties of the canal and river, they blazed and bubbled over with indignation and amazement as if (as the authors of the Break of Gauge remarked,) the worst railway did not afford ten times the accommodation of the best road waggon establishment or canal ever devised.

But such is the nature of man, or of the Anglo-Saxon man at any rate, give him a better and he desires a better still. Yet, perhaps, it is this discontented and encroaching spirit which has raised him from the skins and caverns of his British ancestors to broad cloth and slated houses.

The Birmingham manufacturers called a meeting, which was attended by the officials of the two railways over which their manufactures passed on their way to Bristol; and at that meeting, after making every allowance for bad management on the part of the Birmingham and Gloucester line, it was decided that the Break of Gauge, causing, as it inevitably must, a complete transfer of merchandize, of cattle and passengers, from one line to another, was "*a serious evil, a commercial evil, of the first magnitude.*"

From this Birmingham meeting may be dated the first agitation against the BREAK OF GAUGE.

In the Session of 1845, the London and Birmingham

and the Great Western Companies were competitors for the supplying railroad accommodation to the country between Oxford and Wolverhampton.

The since defunct Railway department of the Board of Trade decided against the Great Western, on objections to the Broad Gauge and the Break of Gauge.

A Committee of the House of Commons, after a protracted inquiry, in the course of which, in addition to the witnesses on local topics, almost all those whose evidence is here abridged, were examined, reversed the decision, on the ground of the superiority of the line selected by the Great Western, but refrained from expressing any opinion upon the merits of the rival Gauges. The Report of the Committee of the House of Commons was adopted, after a brief investigation by the Lords.

So far, with the exception of the Break at Gloucester, which was a grievance of too provincial a character to attract much attention out of the limits of the district affected, the Gauge question had appeared to the by-standing public rather in the light of a crotchety dispute between rival engineers, or a means of attack and defence between rival companies, than what it really is—a question of national importance. But the evidence elicited by the Oxford and Wolverhampton contest excited the attention of the Government, as well as of many independent members of both Houses of Parliament.

About the same time appeared a pamphlet "On the Evils of Diversity of Gauge, with a Remedy," being the substance of a written statement submitted to the President of the Board of Trade, by the author, Mr. Wyndham Harding, one of the witnesses examined

before the Oxford and Wolverhampton Committee, and, as before mentioned, manager of a Broad Gauge railway at the only point where the two Gauges had as yet come into contact.

This was the first popular pamphlet that appeared on this question, and is remarkable as having been confirmed in all its conclusions and its estimates of the expense of obtaining national uniformity, by the last and official reporters on the subject.

Shortly afterwards, on the motion of Lord Dalhousie in the Lords, and Mr. Cobden in the House of Commons, an address was unanimously voted for a Royal Commission to ascertain "*whether in future private acts for the construction of railways, provision ought to be made for securing a uniform Gauge; and whether it would be expedient and practicable to take measures to bring railways already constructed, or in progress of construction, into uniformity of Gauge.*"

The commissioners appointed were Col. Sir Frederick Smith of the Royal Engineers, who had previously held the office of Inspector-General of Railways, Professor Barlow of the Woolwich Military Academy (an ex-Commissioner on Irish Railways), and Professor Airy, the Astronomer Royal.

After a lengthened investigation, which commenced in August, 1845, and an examination of the witnesses, an abridgment of whose evidence forms the bulk of this volume, in January, 1846, they made a Report, which concluded with the following results and recommendation:—

"First. That the Gauge of four feet eight inches and a half be declared by the Legislature to be the Gauge to be used in all public Railways now under construction, or hereafter to be constructed, in Great Britain.

"Second. That, unless by the consent of the Legislature, it should not be permitted to the Directors of any Railway Company to alter the Gauge of such Railway.

"Third. That in order to complete the general chain of Narrow Gauge communication from the North of England to the Southern Coast, any suitable measure should be promoted to form a Narrow Gauge link from Oxford to Reading, and thence to Basingstoke, or by any shorter route connecting the proposed Rugby and Oxford Line with the South Western Railway.

"Fourth. That as any junction to be formed with a Broad Gauge line would involve a Break of Gauge, provided our first recommendation be adopted, great commercial convenience would be obtained by reducing the Gauge of the present Broad Gauge lines to the Narrow Gauge, of four feet eight inches and a half; and we, therefore, think it desirable *that some equitable means should be found of producing such entire uniformity of Gauge,* or of adopting such other course as would admit of the Narrow Gauge carriages passing, without interruption or danger, along the Broad Guage line."

This Report, if carried out, although enveloped in a kind of official coyness, is nothing less than a decree for abolishing the Broad, and establishing uniformity in the universality of the Narrow National Gauge.

The Great Western Company feel this to be the case, and have zealously laboured, ever since the publication of this important document, to destroy its effect. Observations, replies, rejoinders and sur-rejoinders, daily and weekly articles, and pamphlets have swarmed from the modern *ultima ratio* of disputants—THE PRESS. Many ingenious arguments, much wit, some ill humour, and spirit of partizanship of the bitterest character, has been exhibited on both sides. We have even seen a Directorate, including a conservative peer and a conservative commoner, patronizing attacks imputing ignorance and partiality to the Queen's commissioners.

Under these circumstances, it is very probable that

that large body of the public, who, not holding shares in either Gauges, and not allied by blood, friendship, or patronage, with either of the belligerent Directing powers, are selfishly, only anxious to have themselves, their goods, chattels, merchandise, and manufactures, conveyed to and from every part of the kingdom, with the greatest possible convenience, comfort, safety, speed, and punctuality, at the lowest possible cost, will treat with great indifference, if not suspicion, the vehement assertions and hypothetical statements of both the Broad and Narrow Houses.

To supply, in a somewhat condensed form, and arranged under certain specific divisions, the opinions, facts, and figures rendered before the commissioners by the more remarkable of the forty-seven engineers, engine-makers, railway managers, carriers, miners, and railway contractors, this volume has been prepared from the vast blue folio in which their evidence at present lies entombed.

History of the Gauge.

In England, (as will be seen from the Map which, by the kindness of the Proprietors of the *Railway Chronicle,* we have been enabled to append to this volume), about 1,900 miles have been constructed on the Narrow Gauge and 274 on the Broad. No public railways in England are at present laid down on an Intermediate Gauge, those which formerly existed having been reduced to the prevailing dimensions of 4 feet 8½ inches. The Mineral Railways of England vary from 2 feet to 4 feet 8½ inches, the latter only being worked by steam.

In Scotland, the Gauge of the public railways, an

intermediate Gauge having been reduced to the more prevalent dimensions, is 4 feet 8½ inches.

In Ireland, under the advice of a Government Commission, 5 feet 3 inches has been adopted as the national Gauge, although one short line has been laid down on 4 feet 8½ inches.

In France the railways are, under Government instructions, universally laid down on the Narrow Gauge. In Belgium numerous railways laid down by the Government are all on the 4 feet 8½ inch Gauge, with the exception of one line between Ghent to Antwerp which is laid down on a Gauge of 3 feet 9 inches.* In Brunswick the railroads are on the Narrow Gauge, as they also are in Saxony, Austria, and Bavaria.† In Italy, between Leghorn and Pisa, there is a Narrow Gauge line, and those lines which are being constructed between Genoa and Turin, are also on the Narrow Gauge.

In Holland a Gauge of 6 feet 5 or 6 inches has been employed, and in Baden a 5 feet 3 inches Gauge. A railway between Basle and Strasburg is laid down on a Gauge of 6 feet 3 inches.‡

Opinions on Gauge.

Mr. Brunel and his friends, Mr. Charles Alexander Saunders and Mr. Seymour Clarke, seem alone in their

* See *post*, pp. 117, 119, 344, 345.

† Ibid, pp. 3, 119.

‡ "It was made at the recommendation of some engine builder in this country; and the (proprietors) deeply regret it. They say they have derived no advantage from it whatever, and they look forward to a transfer at Strasburg at one end, and at Basle at the other."—Robert Stephenson, *post*, p. 119.

preference for the 7 feet Gauge—Mr. Brunel states very confidently that if he had to work over again, he would adopt a somewhat wider Gauge than 7 feet. At the same time it must be noted that Mr. Brunel not only adopted the Narrow Gauge on the Taff Vale Railway, where, according to the evidence of one witness, the curves "are frightful," but has also made use of it in the lines between Genoa and Turin, which he is superintending, in order to secure uniformity with other railways with which it is likely to come in contact.

Mr. Benjamin Cubitt would like to increase the Gauge to 5 feet 3 inches. Mr. William Cubitt would go as far as 6 feet; all beyond that width, he considers would be a loss in dead weight. He thinks, at the same time, that mineral proprietors would prefer the Narrow Gauge. Colonel Landmann would prefer a wider Gauge; but, in the progress that railroads had made, considers any such proposition hopeless. Major-General Pasley is decidedly in favour of a reduction of all the railways of the kingdom to a Gauge between 5 feet and 6 feet. Mr. Vignoles' theoretical preference is in favour of a 6 feet Gauge; he attempted to introduce it into Ireland, but all the lines that he has constructed, and several which he has lately projected, have been made on the Narrow Gauge, for the sake of maintaining uniformity with connecting lines. On the Wurtemberg lines, which are intended to unite at one extremity with the railways of Baden which are on an intermediate Gauge, and at the other with the Bavarian railways which are on the Narrow Gauge, he has advised the adoption of the Narrow Gauge, in consequence of expecting the chief trade from the Narrow Gauge lines. He prefers a broader Gauge, but he says "the

advantage would not weigh sufficiently to induce me to change."*

Mr. Bodmer, Mr. Bury, and Mr. Gray, all engine builders, desire, *theoretically*, an increase of from 5 to 6 feet, but consider National Uniformity of Gauge by far the most important object. Mr. Bodmer replies to a question, "If it was to be done now I should say *an increase* of six or eight inches, but as we have gone so far, I should say it was not worth the expense of an alteration." Mr. Bury thinks "the engine would be far better if the road were a little wider, but that the speed at which we have arrived is quite sufficient connected with safety, and that "an engine on the Narrow Gauge may be made of quite sufficient power both for velocity for passenger trains, and for luggage trains."†

Messrs. Braithwaite, Bidder, Fernihough, Hawkshaw, Locke, M'Connell, Rastrick, Robert Stephenson, Nicholas Wood, and Edward Woods, a list certainly comprising some of the most eminent railway engineers and engine builders in the world, are unanimously of opinion that the improvements already made have obviated all the difficulties which the 4 feet 8½ inches Gauge formerly presented, and that it is still capable of much greater improvements. Mr. Braithwaite, the author of the 5-feet Gauge on the Eastern Counties,—since reduced, with his approbation, to the national 4 feet 8½ inches,—observes, "*The locomotive of this day is not the locomotive of* 1836; *for all the purposes for which railways can be wanted, there is additional space to crowd in as much power, and more than can ever be commercially beneficial.*"‡ And again,

* *Post*, p. 346. † p. 304. ‡ p. 2.

"A boy may now with facility clean an engine in an hour which would formerly take a man a day."

Mr. Hawkshaw† says:—

"Some years ago it was considered that the trade of the country might be sent along main trunks of railway, and that two, three, or four large lines would subserve the traffic of the country. Now it is quite clear these anticipations are likely to be disappointed—that the fact will be that railways will extend themselves all over the surface of the country, consequently traffic will be split up into various streams and become a kind of intermediate traffic, requiring constant interchange and connection at various points. I think the absolute necessity of extending railways, now that every road is to have a railway, rather goes to show that it is not wise to make those railways of very large dimensions. The question is not so much what is best for one large trunk railway running throughout the kingdom, as what is best as a system to be applied to the whole kingdom; and any arrangement which neglected the extension by branches to every town and every village, would, I think, be detrimental to the country. Supposing the question of Gauge were now open, I have no hesitation in saying I should be disposed to adopt a Narrow Gauge; I don't mean 4 feet 8½ inches precisely, because that is an accidental circumstance."

Mr. Locke states:—

"I have never found, except in the first instance, when our engines were complex, any want of space for the proper working of the engines in the present Gauge. Having got rid of that difficulty, I have never seen any necessity for increasing the Gauge."

Robert Stephenson answers on the same point:—

"As an engine builder, at one time when I was called upon to construct engines of greater power than we commenced the line with, I felt some inconvenience in arranging the machinery properly. We were a little confined in space, and at one time I thought an addition of Gauge to 5 feet would have been desirable, but on no other account.

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* See *post*, p. 30.

Since that time improved arrangements in the mechanism of locomotive engines have rendered even that increase altogether unnecesary."

Mr. William Bass, District Agent to Messrs. Pickford, in the west of England, having "no share in either the Broad Gauge or the Narrow in any way," says, that the "Broad Gauge trucks are most inconvenient for carriers' purposes generally." "A great cumbersome Broad Gauge truck requiring," (on a certain occasion,) "eight men to move it. A Narrow Gauge truck a couple men would have moved with great ease." "It is true that Broad Gauge trucks will take more loading, but it depends entirely upon the description;" and he goes on to say that cheese, and casks of liquor, and many other articles, will not bear the pressure of a heavy load. Mr. Hayward states with respect to the largest packages commonly sent by carriers, viz. wood and hops, that,—

"A packet of hops is from 6 feet to 7 feet long, the narrow waggon is from 7 feet to 7 feet 6 inches wide, so that a packet of hops just fits in laying it across. A Broad Gauge waggon is 9 feet wide, consequently there is 2 feet of waste room in loading hops which cannot be made use of, it is all lost." "In loading them lengthwise you lose ground again; a Broad Gauge truck is 18 feet long, a packet being about 7 feet, you lose 4 feet of length; the narrow waggons on the South Eastern and the new waggons on the London and Birmingham run from 13 to 14 feet long, so we can just squeeze in two packets lengthwise."*

Break of Gauge and Remedies.

Mr. Brunel admits that the Break of Gauge will be an inconvenience. "The amount of it," he observes, "will depend very much upon the particular line of country upon which the change takes place, and upon

* See *post*, p. 262.

the interests of the parties on either side, to increase or *diminish the amount of inconvenience.*" Mr. Seymour Clarke thinks the public will experience very little inconvenience, and that there is no particular difficulty at the unloading at Didcot, *except when people go in shoals to Oxford.* Mr. A. Saunders thinks that where two Gauges meet "there is an inconvenience, but I cannot call it an evil," which is certainly a very ingenious, but not very definite answer to an inconvenient, not an *evil*, question.

These three gentlemen all propose the same remedies for the Break, viz., small packages and parcels to be moved by a force of porters—or the body of the carriages to be removed bodily from the narrow wheels and axles, and laid down on broad frames and wheels—or to run the whole carriage, wheels and all on broad trucks, —and to pack minerals and coals in iron boxes, two to be transferred to one Broad Gauge truck.*

Passengers, Mr. Brunel proposes, shall walk across a platform to the other carriages, as at Didcot. But when he is asked—*Having dealt with passengers, and having had now some considerable time to think of the question of goods, since it was brought forward in the last session of Parliament, have you made up your mind at all as to the mode in which you would arrange respecting them?* To which he answers—"No; because it must depend upon what the other companies choose to do on the other side. If they do not afford assistance to exchange,—I will not say if they throw impediments in the way, the mo'e must be different from what it would be if they did."

Mr. Cubitt considers that this transfer is a "mere

* See *post*, p. 360.

matter of cost," which indeed is perfectly true, and the same may be said of the additional price of a bale of cotton carried from Bristol to Manchester by rail. Mr. Vignoles does not believe the public could be made to pay the extra expenses involved by a Break of Gauge. In practice, as before stated, he avoids the difficulty by invariably preserving the strictest *uniformity* between the lines he constructs and the lines he runs into.

Mr. Stephenson, Mr. Nicholas Wood, and Mr. Ellis the Deputy Chairman of the Midlands, give instances on the Erewash, on the Liverpool and Manchester, and on the Midlands Railways, where the loose boxes, and other remedies proposed by the three advocates of the Broad Gauge have been tried on a large scale and entirely failed.

Mr. Locke considers loose bodies or narrow carriages on broad trucks positively dangerous.*

Mr. Wyndham Harding, who was compelled, from his position as manager of the first Broad Gauge line that ran into a Narrow line, to consider every possible expedient for the purpose of overcoming the difficulty, says,—

"Among the peculiar advantages of railways is punctuality, as well as despatch; whereas when you have a Break of Gauge, it is quite impossible to ensure punctuality." "Taking a passenger out of one carriage, moving him with all his articles of luggage, and all that accompanies him into another carriage, evidently gives rise to delay; but when horses and carriages accompany passengers that increases the delay. I have seen two or three hours occupied in getting a restive horse into a truck. With regard to merchandise, you stop your train, you take it to pieces, and disarrange it, to unpack and repack them in trucks of a different size, to take an inven-

* See *post*, 195.

tory of the whole as you pass them over. This costs a great deal of money and time." "The goods are continually injured, wrongly invoiced, and misdirected: it must always be so when work is done in a hurry."

He also gave in a return from the Gloucester station, proving that goods trains fluctuate in amount of load exceedingly; on one day 124 tons arrived, on the next only 5 tons. It is, therefore, "impossible to fix on an average force of porters equal to the greatest amount of work; one day you will have half your porters standing still, the next you will have more work than they will possibly be able to do. If you shift minerals, coals, or lime, you do them such an injury that you would lose the traffic; in order to avoid shifting, you would use mechanical expedients." He treats at length from the results of his personal experience, the objections to shifting bodies and other like expedients:—

"I do not think that any mechanical arrangements, consisting of wheels capable of running on both Gauges, can accomplish the object for which they are designed: I do not mean to say that it is a matter of difficulty to shift the body of a carriage from one carriage to the other, I do not think it is. I have myself designed a machine, and other people have no doubt done the same, which overcomes the difficulty to a great extent, perhaps altogether; but the reason why I think such arrangements on principle never can generally apply, is this, that they involve two sorts of stock, one the ordinary or permanent stock, if we may so call it, and the other the shifting stock, capable of undergoing this process of trans-shipment. It also requires the concurrence of a great many Companies, not merely to consent to such stock being built, but to their continually, even daily, and all their servants taking care that it is used as it is intended to be used, and for that purpose only, otherwise the arrangements will fail altogether, and rather increase the evil than mitigate it. Now supposing all the railways were under one management, even assuming that to be the case, I do not think it would then be practicable to bring into use two sorts of stock. We find already, that there is a

great difficulty in carrying on a goods traffic, in getting hold of any stock at all from the fluctuating nature of the traffic, especially the extraordinary rapidity with which everything goes on; in the goods shed you get hold of the first goods truck you can, and continually those out of repair are sent, although contrary to order; and the necessity of thus using the first truck that comes to hand without distinction is shown by the clearing-house system, which many Companies were originally averse to, but which they were subsequently obliged to adopt. The Great Western were against it at first at Bristol, but in three weeks they were obliged to give way. They found it impossible when stock was there not to seize and use it in spite of all regulations to the contrary, and I feel satisfied that you cannot keep in use all over the country, or even at the principal stations of the country, two sorts of stock, each of which shall be applied to a particular traffic of the district of the opposite Gauge. For that reason, I think that mechanical ingenuity is almost thrown away upon the subject, because when you have overcome the apparent difficulty the real difficulty remains."

But by far the most striking evidence given on the Break of Gauge, as well as upon the comparative merits of the two Gauges is that tendered by the carriers. Making every allowance for the natural prejudices of Mr. Chaplin and his partner in favour of the Narrow Gauge lines with which the former is connected, it is still distinctly proved, from the facts brought forward by these gentlemen, as well as the parties connected with Mr. Pickford, that a Break of Gauge necessarily involves trans-shipment, and that trans-shipment involves loss by misdirection and pilferage, as well as a detention of hours and days, and an actual money tax of from 1*s.* 6*d.* to 3*s.* 6*d.* per ton.

Passengers may be easily moved at a slight expense of time, and some annoyance; but it is evident that our railway system will not be perfect until a cargo of merchandize of all descriptions may be sent to and from the

most distant points of the kingdom, with the safety and punctuality of a post letter.

Mr. Bass, whom we have before quoted, states that "the average detention of trains at Gloucester, in consequence of the Break of Gauge, is from four to six hours." He would prefer any Gauge to a Break of Gauge; that there is hardly a day passes but goods get wrong; and that, supposing there were a continuous Gauge from Birmingham to Bristol through Gloucester, goods would travel the distance in about five or six hours; and now, "they are sometimes two days, or more. We have no dependence upon them, because if we have not time to make the transfer before the train leaves, the train from Gloucester to Bristol leaves at a certain time without waiting for our making the transfer, and frequently delays them till next day: there is no regularity at all." And he states further, "*I am quite sure that Bristol cannot rise as a port* without a continuous Gauge."

Mr. Evan Jones, Messrs. Chaplin and Horne's agent at Camden Town station, produced a return showing that 2948 tons went through Birmingham for his firm without being disturbed; and that only 190 tons of goods were transferred and re-assorted. He estimated the loss in damage, by transfer, at a shilling a ton; and, in addition, from 1*s.* 6*d.* to 2*s.* 6*d.* for the cost of transfer; and stated that trucks were frequently sent through half loaded, to avoid the expense and damage of unloading and transferring.

This evidence was in answer to Mr. Brunel's theory that the majority of all loads were re-assorted on passing through large towns.

No graziers or farmers were examined by the

Commissioners; but Mr. N. Wood, of Newcastle, Mr. Bruyeres, and Mr. Mills, of the London and Birmingham Railway, were enabled to bear witness to the extreme difficulty of trans-shipping cattle and pigs. Agricultural produce, like minerals, although for a different reason, cannot bear high tariffs.

South Wales is one of the parts of this kingdom where rich mineral tracts remain untouched, and comparatively valueless, from the want of cheap conveyance to our manufacturing districts. "Hitherto," says Mr. Budd, a manager of copper works and coal mines, "South Wales has scarcely participated in the retail trade of the country; the iron works are chiefly 15 or 20 miles inland, so that the cost of putting the iron on ship board is from 3*s*. to 6*s*. a ton; and it has been chiefly sent by sea to London, Liverpool, and elsewhere, for foreign shipment. It has ascended but a little way into the interior; but if an overland communication takes place, a lot of 10 or 20 tons can be made up and delivered at Derby, Leicester, and other places open by railway. Five-shillings a ton, at a penny a ton per mile would carry it a long way inland."

It is along the coast of this district that the Great Western Railway are constructing a line which they propose to lay down on the Broad Gauge. It appears that "all the works in Wales are situated in a series of vallies, one after the other; they may be called gullies, so narrow are they, and sharp curves are unavoidable." To work from these iron works, the tram roads in use are many of them as narrow as 2 feet 8½ inches; and the lines running down to the rising port of Newport, are on a Gauge of 4 feet 4 inches. There are not less than 90 miles of these

* See *post* p. 275.

Narrow Gauge roads. There are also embankments which have been constructed for some of these tramways, for instance, at the Tirhowy works, in Monmouthshire, upwards of 180 feet high. It would, of course, be a very formidable expense to increase this embankment to the width required by the Broad Gauge.

After stating these facts, Mr. Budd and a Mr. Brown, who is manager of Sir Robert Price's iron works, &c., "bred and born in the coal and iron trade," both agree that the expense of adapting the present tram ways to the Broad Gauge, the difficulty of working the Broad Gauge carriages round the sharp curves of the Welsh valleys, the unwieldiness of so large a waggon as the Broad Gauge waggon, would render it most impolitic in a commercial point of view, if not physically impossible, to introduce Mr. Brunel's system into the district, in the prosperity of which they are so much interested; while, with respect to the Break of Gauge, which must be inevitable if the projected Broad Gauge lines are carried, they look upon them as virtually excluding South Wales from competing for a share of the retail iron trade of England. Mr. Budd says, "*I cannot fancy how five hundred, or six hundred, or seven hundred tons of iron (which, there being no Break of Gauge, would certainly reach its destination by the next morning), could be transferred and shifted in the course of the night.*"

After such evidence, although on inches of Gauge there may be a difference of opinion, on the enormous evil of a Break of Gauge there can be none. Captain Laws, whose evidence conveys in a blunt sailor-like style the soundest commercial axioms, observes most truly, that "the development of the mineral wealth of the

kingdom, on the fringe of which we have as yet barely touched, is ten thousand times more important than travelling 70 miles an hour." Neither our farmers, miners, nor manufacturers can have an untrammelled field for their exertions until national uniformity of Gauge is established.

It is in vain to seek the point at which the least traffic passes *now* for the establishment there of the Break of Gauge. In the present daily changing state of the population, it is impossible to say *where* there will be the least traffic, and most impolitic to raise up artificial barriers, such as Breaks of Gauge, against a future interchange of produce and manufactures, or the rising prosperity of an, at present, unnamed port. Take the instance of the Western district, where there are few manufactures but many fine harbours; a Break of Gauge may prevent the rising of a new Liverpool, Birkenhead, or Southampton, or South Wales, where a Break of Gauge would hermetically seal a hundred valleys rich in coal and iron.

The military men examined, sum up all in comparing the effect of a Break of Gauge on an army to a halt compelled by a ferry.

General Burgoyne observes, that in the case of an attempted invasion, it would take an enemy, judging by the experience this country has had in that description of warfare, a very considerable time before they could land even twenty thousand men, with all their munitions of war. In the mean time, it is presumed that notice of the approaching hostile fleet would have been given by our picquet steamers. By means of the electric telegraph, the threatening news would be instantly conveyed from the nearest to all the furthest points of railway communication; by the same means,

under a *uniform system of Gauge*, the whole railway and locomotive stock of the kingdom, carriages, waggons, trucks, horse boxes, &c., would be placed at the disposal of the military authorities, and assembled at convenient stations for the conveyance of an immense army to the part of the coast threatened. In time of war the militia would of course be organised all over the kingdom; so that whoever dared to put in practice the steam invasion theory, would find himself in the face of from one hundred to two hundred thousand men of the same stamp as those who fought at Cressy, and at Poictiers, at Blenheim, and at Waterloo.

Thus steam on land will counterbalance steam on sea, if we do not permit the crotchets of an engineer, and the isolating pride of his patrons, to build up artificial barriers against continuous conveyance.

An army such as General Burgoyne contemplates with all its artillery and munitions would require seven or eight thousand carriages!

Safety, Speed, and Power.

The evidence completely dissipates the vulgar notion that a Narrow Gauge railway carriage is likely to topple over from top-heaviness: no instance of the kind is on record, the actual centre of gravity on both lines being about the same.* The idea has, no doubt,

* "To say that they [Narrow Gauge carriages] were as safe would be reasoning against mathematical demonstration. It could not be safer. * * I can demonstrate it in this way: we very frequently have a single horse in a horse-box; that horse is frequently put on the extreme side of the horse-box. The horse-box is the widest vehicle we have, and the horse is clearly the highest load in proportion to his centre of gravity, and if there is any yielding at all he yields to it, and gives a much greater effect toward upsetting the train than anything else; but we never hear of one upsetting."—*Capt. Laws.*

arisen from the term Narrow Gauge having come into use, which conveys the idea of a particularly narrow carriage, the fact being, as before mentioned, that there is no road carriage in use in England of a greater width than 5 feet; while in Belgium a railroad 60 miles long is worked with perfect safety and great economy on a Gauge of 3 feet 9 inches (see Mr. Stephenson's evidence, p. 119). Mr. Seymour Clarke, when examined on this point, at first admitted that the Narrow Gauge lines were "practically safe;" but afterwards, when insinuating that Narrow Engines ran off the road at high speeds from want of a wider base, he was asked,—

"*Q.* But your engines do get off the line sometimes?
A. Not from that cause.
Q. But they do get off?
A. They get off at points!"*

The Appendix to the Report of the Gauge Commission gives an abstract of the Reports made to the Railway Department of the Board of Trade, "on those occasions when engines and carriages, or some part of the train have run off the line, without any known obstruction between September, 1840, and 1st January, 1846." Of course any gauge is equally liable to accidents from collision. From this abstract it appears that within the time specified nine accidents have occurred on the Narrow Gauge lines, and three

* Among the expedients most in favour for avoiding the Break of Gauge, is that of laying down a double Gauge, so as to enable both broad and narrow carriages to traverse the line. This plan would not only add to the expenses of the construction and working any line, but increase the number of points nearly five-fold. *See* pp. 192 197, 298, *post.*

on the Broad Gauge. There are about 270 miles of Broad Gauge railways, and about 1,900 miles of Narrow Gauge railways; therefore as the Narrow is to the Broad in the proportion of eight to one, it is quite evident that even if twenty-four accidents had occurred on the Narrow Gauge, it would still have been *as safe* as the Broad Gauge. To put this in an arithmetical form: three accidents occur on one mile of one railway system, and nine accidents on eight miles of another system.

Undoubtedly, no system of conveyance has ever been devised so safe as that afforded by railways. But a rate of speed which may be perfectly safe on a firm and settled road, will be most perilous on one but lately constructed, or after a succession of storms and droughts. With a clear course, on a fine day, a train may be driven at a pace it would be frightful to contemplate in foggy November weather. Mr. Locke observes, "I would neither increase my wheel nor my speed, till I had more experience not only in the construction, but also in the strength of materials. You can never get over the inequalities of road arising from the change of temperature and weather. You may have the most perfect road, that has been standing for months, and run upon daily, and you shall have a shower of rain, or a continuation of wet weather during the time the trains are running, and in two days the road may become positively dangerous, and no ordinary precautions can meet that." Further on, speaking of the South Western Railway, he says,—

"Our time to Southampton is two hours, and the distance is seventy-eight miles, very nearly forty miles

an hour, including stoppages; and I am quite sure that if it were a matter of necessity, we could travel at fifty miles an hour. . . . . I do not think that speed safe either on our own line or any other that I have ever been on."

It has also been remarked by Mr. M'Connell, and others, that heavy engines, such as those employed by the Great Western Company to draw their express trains, do serious injury to the road, by thundering along, and as it were hammering the rails with such force, as to crush the metal and drive them out of Gauge, so that accidents are, as it were, prepared, for the trains following in the track of the express.

The advocates of both systems claim the superiority in *speed* where the gradients and curves are equally favourable.

There is no railway existing which can compare with the Great Western in the levelness of the road and flatness of its curves; an enormous extra expense was incurred for the express purpose of obtaining high speed. There are many lines where it would be impossible to avoid acute curves, especially those constructed through those mountainous districts of Wales where minerals abound; there are others where, from the nature of the traffic, any extraordinary expense in securing a level track would involve low, or no dividends, and high fares. It may be taken as an invariable rule, that great expenses involve high fares. In Mr. Locke's examination we find the following pertinent question and answer:—

"It is generally admitted that, on the Great Western, a greater speed is obtained with the ordinary trains than on other lines?

Mr. Locke :—

"I think it is so, but I think that that may be accounted for in some measure by this circumstance: the trains stop less frequently than upon some other lines. . . . You must also bear in mind that they have much better gradients on the Great Western; therefore, in speaking of the speed of the Great Western, you ought to attribute the difference in some measure to the gradients."

On the same point Mr. Bidder observes, with great truth :—

"You save a great deal of time in from twenty miles an hour to forty miles an hour; but an increase from forty to fifty miles an hour, is not of that consequence. . . . . *I do not think the express trains can be introduced to any extent, with any safety, without the electric telegraph, to forewarn them of any impediments in their way.*"

The express trains, which have undoubtedly been introduced and brought to their present perfection by the Great Western Company, are extremely convenient and agreeable for those who travel by them; but it may be doubted whether, placing considerations of safety on one side, they fall exactly within the range of objects to be aimed at in a National Railway system. On the Great Western line the population lies in patches at the extreme stations between London and Bristol. From Reading to Bath there is scarcely any station of importance. Indeed, according to the original plan, the Great Western Railway was to have ceased at Bath and at Reading, leaving the intermediate traffic to be supplied by ordinary road conveyances. The Great Western line has very little cross traffic. It is, therefore, in every respect, well adapted for running express trains, which stop at very few stations, and thus save all the time lost by

ordinary trains accommodating local traffic. Yet, even on the Great Western line, it is not unusual for trains which have preceded the express to be delayed for very long periods waiting at *sidings* for the fast train to pass, not daring to proceed for fear of being overtaken and run into. So that, in fact, a very large number of persons are delayed on their journey in order that a select few, able to pay a higher price, may enjoy the luxury of leaving later and arriving sooner at the end of their journey.

A railway conveyance should not only be swift, but punctual and cheap. Hence express trains, especially upon lines where the cross traffic is frequent, and the population lies thick, are not only dangerous (without the electric telegraph), but highly inconvenient to the mass of the travelling community,* because the increased speed is obtained by an increase, and that an irregular increase, of the time occupied by ordinary trains.†

There is very little difference between the speed of the ordinary trains on the Great Western and on other lines of equally favourable gradients; but the Great Western can, in consequence of the peculiarity of its traffic, halt less frequently with less disadvantage.

* By the returns made to the Board of Trade for the twelve months ending the 30th June, 1845, it appears that the railway travellers conveyed during that space of time were composed as follows:—

1st class passengers . . .	5,474,163.
2nd class passengers . . .	14,325,825.
3rd class passengers . . .	13,135,820.

Thus the second and third class passengers are more than four times as numerous as the first class, and even of the first class a minority only pay the higher required by the express trains.

† *See* Table on next page.

With respect to the comparative *Power* of the two systems, we have, in Mr. M'Connell's evidence, the results of an actual experiment made between the Broad Gauge engines on the Bristol and Gloucester line, which are of the latest construction, and the Narrow Gauge engine on the Birmingham and Gloucester line. The waggons were loaded expressly with the view of making as little dead weight as possible. There were 36 waggons upon the Narrow Gauge, and 25 upon the Broad Gauge. The gross load of the Broad Gauge was 235 tons, of the Narrow Gauge 254 tons. The Narrow Gauge carried 35 tons 15 cwt. *less* dead weight, and 55 tons 2 cwt. more of profitable load.*

† ABSTRACT OF DETENTIONS TO ORDINARY GOODS AND PASSENGER TRAINS ON GREAT WESTERN RAILWAY TO ALLOW THE EXPRESS TRAINS TO PASS.

For the 9, 45. A.M. *Down Express to pass.*

TRAIN.	LEAVING		HALTING	DETAINED H. M.
Goods	Paddington at	4 0 A.M.	Swindon . .	1 0
3rd Class	„ „	6 30 A.M.	Wallinford Rd.	0 25
Passenger	„ „	7 30 A.M.	Bristol . . .	0 12
	For the 5, 30. P.M. *Down Express to pass.*			
Passenger	Paddington at	4 45 P.M.	Twyford . .	0 17
Goods	„ „	2 45 P.M.	Reading . .	1 5
	For the 6, 30. A.M. *Up Express to pass.*			
Goods	Bristol at .	3 0 A.M.	Steventon . .	1 10
3rd Class	„ „ .	6 30 A.M.	Box	0 25
Passenger	„ „ .	7 0 A.M.	Reading. . .	0 12
	For the 12, NOON, *Up Express to pass.*			
Goods	Exeter at .	8 5 A.M.	Highbridge . .	0 25
Passenger	„ „ .	10 0 A.M.	Farrington Road	0 19

* It is given in evidence that the Manchester and Leeds Railway, which is constructed on a series of sharp curves, conveys on an

In the early days of railways, the engines for goods trains were made very light; but it has been found that heavy engines for such trains are more efficient and economical. Mr. M'Connell describes some on the Manchester and Sheffield railway, as well as others constructed by himself for the Birmingham and Gloucester line, which can with ease draw from eight hundred to one thousand tons, up steep inclines, at a moderate speed. These are weights which, in practice, companies are seldom, if ever, called upon to convey at one time. It must also be observed that, in treating of *Power*, we must consider *useful Power only*.*

It is the peculiarity of the railway system, that, except on very rare occasions, a train consists of a very large proportion of dead weight. A single passenger over and above a full load requires the attaching of an additional carriage to the train; a single ton of goods will often be the sole freight of a whole truck. It is found, that even on Narrow Gauge lines, the intermediate traffic, that is, the traffic of the small towns between the principal points, is carried on in a number of half-laden trucks. Mr. Stephenson says, "All the

average 1000 tons of merchandize a day, [not at a time] and this traffic is conducted with the utmost ease, safety, and punctuality, over a country where to construct or work a Broad Gauge line would be a physical impossibility. It cost 40,000*l.* a mile; in consequence of the height of the embankments and viaducts, and the difficulty of the tunnels the additional breadth required by the Broad Gauge would have amounted to from 6000*l.* to 8000*l.* a mile.

* Great feats in speed have been performed by both Narrow and Broad Gauge engines; but on examination, it will be found that these feats are performed over very straight and level lines, and by an increase of weight on the engine and tender, which at high speeds is neither safe nor profitable.

intermediate traffic of any country is carried on by trucks sometimes not having half a ton in them. I do not suppose there is a single truck upon the London and Birmingham Railway, or the Grand Junction Railway, for intermediate traffic, that has an average of more than a ton in it." An intermediate traffic carried on by Broad Gauge trucks would frequently present the spectacle of five tons of useful load conveyed in ten trucks weighing fifty tons.

In concluding this summary and commentary on the Appendix to the Gauge Commission report we cannot refrain from observing that there is one important point which the evidence establishes most clearly,—the gross injustice of the attacks made by the advocates of the Great Western Company on the Commissioners. So far from their having decided against evidence, it is quite clear that unless they had reported against the testimony of every engineer except Mr. Brunel, of every secretary except Mr. Saunders, of every manager except Mr. Seymour Clarke, and of every engine builder except Mr. Gooch, as well as against the united evidence of miners and carriers (not one of which two practised and intelligent classes did the Broad Gauge advocates call), they could not have reported in favour of the Broad Gauge.

The Case for National Uniformity.

The existence of 1,900 miles of Narrow Gauge railways is alone a strong plea for their continuance and extension, even if barely equal in general advantages to the Broad Gauge lines; but the whole tenor

of the evidence goes to show, that while in *available* speed and power the Narrow Gauge is fully equal to the Broad Gauge in commercial convenience, it is vastly superior. Economy means low fares and low dues.

Mr. Brunel and his friends do not contemplate extending all the lines of the kingdom to the Broad Gauge; they only propose to push it into certain districts, as an auxiliary to and in direct connection with the Great Western. The breaks of Gauge, which will be produced by crossing or running into Narrow Gauge lines, Mr. Brunel justifies by assuming that theory of railway districts and of inevitable change of carriages for passengers, and which he indicates where he says that "if a net-work of railways is made all over England, I think it will be impossible that passenger-carriages can be running all over England," and where he assumes that at certain points all railway goods-trains must be stopped and re-assorted. This theory as to the goods trains, has already been shown to be a complete error, by the evidence of the Carriers. The ultimate effect of the extension of a uniform railway system is still more clearly shown in the operations of the CLEARING HOUSE.

We are fortunately enabled to furnish an account of this interesting and valuable institution, from a pamphlet* lately printed for private circulation by its ingenious author Mr. K. Morison.

It appears that soon after the opening of the continuous lines of railways between Liverpool and London, it was found that travellers would not be content with

* "The Origin and Results of the Clearing System which is in operation on the Narrow Gauge Railways."

the mere acceleration of speed, but required to be carried through at one charge, and if possible by one conveyance. The same demand was made for goods. This arrangement was carried into effect; but although the public were better served, the accounts of the companies interchanging fell into sad confusion. Each company had charges against those which ran over its lines, and in like manner owed money to those lines, giving rise to an interminable affair of cross accounts. Then, as railways increased, some were prosperous and some were poor. The prosperous were well supplied with carriages, waggons, trucks, and all that comes within the title of "Railway Stock;" the poor companies had as little as they could help, and made up for the deficiency by unacknowledged borrowings; so that, altogether, the interests which should for mutual and public good, work most harmoniously, clashed in a manner that could be pleasing only to the lawyers of the disputing companies. The solution of the litigious maze was found in a plan derived from that of the City Clearing House, which was carried into effect under the auspices of Mr. Glyn and Mr. Hudson:—

"On the 2nd January, 1842, the system of the Railway Clearing House came into operation on the railways extending from London to Darlington in one direction, and from Manchester to Hull in another. It was adopted at subsequent periods by the companies whose railways extend from Darlington to Carlisle, Sunderland, Hartlepool, and Scarborough; and from Birmingham to Gloucester, Birkenhead, Liverpool, Fleetwood, Lancaster, and Manchester. And in a few months it will be in force in all the railways included in the area defined by a line passing from London through Gloucester, Liverpool, Fleetwood, and Glasgow, to Edinburgh;—and returning by Berwick, Newcastle, Scarborough, Hull, Yarmouth, and Cambridge, to the metropolis; or, in other words, on all the Narrow Gauge Railways in Great Britain lying north of the Thames, with the exception of the

few short lines which are beyond the limits of the area just described."

"The main principles of the system thus widely diffused, are, *first*, that passengers shall be booked through at all principal stations, and conveyed to their destination without change of carriage;—that horses and cattle shall likewise be sent through without change of conveyance, and that goods shall, in the same way, be carried through without being either shifted or re-assorted. *Secondly*, that the companies respectively shall pay a fixed rate per mile, for such carriages and waggons not their own property, as they may use; and a further sum per day by way of fine or demurrage for detention, if kept beyond a prescribed length of time; and *lastly*, that no direct settlement shall take place between the companies in respect of any traffic, the accounts of which have passed through the Railway Clearing House."

In order to work out the *clearing* principle there are sent daily from each of the Clearing House stations (including all the principal booking stations of every line forming a part of the Railway Union),

"1. A return of the passengers booked through.
2. A return of the horses, private carriages, and cattle booked through.
3. A return of the parcels booked through.
4. A return of all the carriages, waggons, &c., which have arrived or been discharged either loaded or empty.

From these returns the accounts of what is due to and owing by each Company is made out at the Clearing House, and, after being examined and approved by each Company, "*the final settlement of the accounts is effected by the railway clearing, paying, or receiving the balances, as the case may be, through the hands of the bankers, who act as agents to the several Companies.* In this way all the transactions of one Company with all other Companies, amounting frequently to many thousand pounds a week, are cleared weekly by a sum seldom exceeding a few hundred pounds."

The means which the Clearing House possesses for having each vehicle from the moment it leaves the

parent line until it returns to it, and the plan adopted of charging mileage for stock used, and demurrage for stock detained, have put an end to the practice before referred to, of borrowing from neighbours to supply an improper deficiency in carrying vehicles.

From these returns, for the year 1845, we find that 517,888 passengers were each conveyed through an average distance of 146 miles,—the average length of the lines travelled over being forty-one miles, so that each passenger travelled over four railways on an average, and must have passed three junctions or points of convergence—to accommodate these passengers, 59,765 railway carriages and 5,813 trucks, carrying private carriages, were sent through. There were also sent through, in the same year, 7,573 horse boxes, 2,607 post-offices, and 180,606 goods waggons, beside waggons conveying minerals, of which no record is kept in the Clearing House.

There are other circumstances connected with the Clearing House which render it a most valuable Institution. The control is vested in a committee, composed of the Chairman of all Companies who form part of the Union. Their meetings tend to produce harmony and also *uniformity* in their respective arrangements, and to impose a check "on the disposition to introduce diversities of system, which, from some motive or other, Railway Managers have so often evinced."

It is scarcely necessary to observe, that if the Great Western Railway succeed in introducing the thirty Breaks they contemplate, on all those lines, the Clearing system will be inapplicable; as a physical obstacle is raised up the continuous transit after the Clearing system has succeeded in removing so many moral obstacles.

Wherever a Break of Gauge occurs, there a double tax must be imposed upon the public—a tax of time and a tax of money. A double stock of vehicles of all kinds must be maintained, and a proportionate number of servants. A load of goods sent from a port across a Break of Gauge must encounter the dangers of delay from not finding a sufficient number of waggons on the other side to perform the remainder of the journey, in addition to the expenses of unloading and reloading, and the probable loss by breakage and pilferage. On a series of railways laid down on a uniform system the same load may be sent hundreds of miles without ever being disturbed, and with an absolute assurance of reaching its destination at an hour fixed on its departure.

It is as certain that the parties making use of railways pay for an unnecessary expense incurred in their construction, working, and maintenanoe, as that taxes levied at a custom-house on articles of necessity are paid by the consumer.

Railways have already greatly advanced that change which was begun by our admirable although now almost extinct canal system, and our not less admirable and quite extinct coaching system. As they extend their iron arms, direct communication and interchange of mutual wants, of corn and timber, cucumbers and cabbages, for coal and calico, corduroy and guano, is becoming more and more the order of the day. All towns, all hamlets, even the remotest rural districts aspire to sharing the benefits of the untiring steam-horse; fishing villages claim to be ports, and secluded valleys proclaim the rich mineral treasures awaiting the modern Open Sesame of carriage at a penny a mile per

ton. We must not check this progress, or permit any body of men by ambitious extravagance and selfishness, to check the wide interchange of home trade from which all manner of good may be anticipated.

There was a time when a few county towns monopolized the whole inland trade of extensive districts, when a few ports received and sent forth all our foreign trade, and a tall column of profits stood between the producer and consumer.

Then the conveyance of merchandise was carried on by long strings of bell-bearing pack-horses, picking their cautious way over rough bridle roads, and here and there by broad-wheeled waggons, moving on highways even more solitary than they are now. By these expensive modes the wholesale dealer of the County Metropolis received cargoes once or twice a year of the various kinds of goods destined to supply his customers, the retailers of the country round, and the pedlars, who then conducted two-thirds of the provincial dry goods' trade. The roads to London were dreary and dangerous, consumptive of time and money. No shopkeeper thought of sending up to town for ten pounds worth of goods; he drew from his neighbour the wholesale man, and he would no more have dreamed of going up to select his spring stock than of making a pilgrimage to Rome. Manchester, to half England, was a far off place in the barbarous north. The spinning-jenny was not, and calico was burdened with a heavy excise as a dangerous rival to our ancient woollen manufactures.

Each county town was of itself a small metropolis. Litchfield, Chester, Warwick, and other now decaying cities were the sites to which the surrounding gentry

and aristocracy resorted for their amusements in winter and their purchases all the year round. When Sir Thomas Leathers required a stock of claret, new saddles, a beaver and bob wig, or Lady Leathers a supply of groceries, lace, satin, cambric, the latest fashions of hoops and head-dresses, there was no railroad to whistle them up to Bond-street and back again within twenty-four hours; so they proceeded along in full-blown state and dignity to the county town in their coach-and-six, or chariot-and-four, and there laid in an ample supply of soap and sugar, tea, toys, feathers, and fans, in fact all that might be wanted for use or pleasure in the huge mansion of a baronet of the old and nearly extinct sort. There were no express trains, no posting at twelve miles an hour, in those days; no printed calicoes at threepence halfpenny a yard, no penny magazines, no penny post, no penny-a-mile carriages, no maid-servants in silk gowns with parasols, no tea at three shillings, no white sugar at eight pence a pound. It was by the few at large profits, instead of the many at small profits, that money was made. Then, as the small capital, sold to all the district, of which it was the metropolis, so it bought from all that district. The carriage of agricultural produce and local manufactures was too expensive to tempt the owner past the first great city on the route. All this has passed away, never to return. Pack-horses, and bridle-roads, highways, and broad-wheeled waggons have been succeeded; first by canals and horse-drawn barges; last, by railroads and flying locomotives.

The first effect improved means of conveyance was to destroy the wholesale trade of these provincial capitals,

year by year; London became more and more the great warehouse of internal trade, so that all roads seemed to end there.

But railroads have brought about a new commercial revolution. The centralizing effect of highroads, canals, and the first railroads, is neutralized by the creation of more direct lines of communication. The stream of commerce is increased and divided. The system of eagerly competitive commercial travellers—of rapid, Rowland-Hill-transmission of letters, and almost equally rapid transmission of merchandise (where no Break of Gauge intervenes,) leads the country shopkeeper to obtain what he requires direct from the manufacturer; and, perhaps, if his business will afford it, to select it in person. Nothing could tend more to advance this movement toward a more equal distribution of the wealth of the country than a uniform railway system.

The evidence on the Gauge Question affords many striking illustrations of the undeveloped wealth of this country—agricultural, mining, and manufacturing. So far from our being, as some continental philosophers love to represent, worn out and exhausted,* —just passing that culminating point at which so many and so great empires have paused, tottered, and fallen, to

"Point a moral, or adorn a tale,"—

there cannot be a doubt that we have within our island richer and more abundant sources of wealth than all that we have hitherto displayed in war and peace. We find that while in the purely agricultural districts produce sells

* England and Russia two bloated giants.—*Michelet's 'People.*

at barely remunerating prices, while timber actually rots in the woods for want of a market, and the peasantry shiver through the winter for want of a better fire than faggots, the produce of dead wood gathered by their landlords' sufferance, there are many and rich coal mines unopened from the same cause —the absence of all means of conveyance to a market, —and there is in the manufacturing districts a much greater demand for agricultural produce of all kinds than can easily be satisfied. A straw shows how the wind blows. The demand for a luxury affords some idea of the demand for absolute necessaries. When we learn from the "Evidence" that Manchester consumes in the season from ten to twelve *tons* of cucumbers a week, and that 150 tons of green vegetables are carried daily by one railroad from that town along the valley of the Calder,* we can form some idea of the enormous demands for corn, flour, meat, bread, butter, cheese, and poultry — all articles which may be bought at comparatively low prices in many parts of the south-west, and west of England, and in all parts of South Wales. The same districts, or, at any rate, Hampshire, Wiltshire, Devonshire, and Cornwall suffer miserably for want of fuel. Soon after the Bristol and Exeter Railroad opened, the landlords on the line lost the sale of faggot wood; the farmers and labourers were enabled by the new conveyance to supply themselves with coal; at the same time the price of butter,

* If a Narrow Gauge Railway were made there, they would send minerals down direct, and return corn and fruit; they get a great deal of fruit in that district, and other garden stuff, particularly cucumbers. I have seen as many as four railway waggons coming from the neighbourhood of Rugby, full of cucumbers, to Manchester· about twelve or fourteen tons of cucumbers.—CAPT. LAWS.

cream, and poultry rose in Exeter market. This one instance exemplifies what we may anticipate from the general extension of a wise railway system.

Our agriculturists have just received, or imagine they have received—and, in such matters, imagination goes a long way, "a heavy blow and deep discouragement. They fear low prices; and the groans and cries of alarm are loudest and deepest from those most distant from the large, unceasing, and increasing demand for all that farms produce afforded by the "Great Metropolis" and the manufacturing counties. There has been a talk of compensation for the agricultural interest, of money to be lent to landlords, and a new arrangement of turnpike acts, which, Heaven knows! is wanted badly enough. The best, the only real compensation, will be found in extending the farmers' markets, and giving him thousands for customers where he only had hundreds before, for his purchases the range of cities instead of the neighbouring village. This can only be done by an extension of the railway system, and that on such a scale that it shall be worth the while of the Company to attend to the agricultural traffic. At present the parish roads all converge toward the highways and the nearest town or village; in a system adapted for a rural district these roads will be turned toward the railway stations.

Mine proprietors have been sufficiently acute to compel railway companies to provide sidings and other conveniences for sending off their produce. The agricultural members have hitherto been too busy in watching a parchment protection to obtain such advantages for their constituents. They must awake now, explore, and realize the advantages actually within their grasp.

We shall then see, on market days, farmers proceeding with their stock and produce to the roadside railway station, provided as the focus of a circle of farms, and they will think no more of going fifty miles to market with a pen of sheep, a van of cattle, and a waggon of grain hired in joint stock, than an Irish pig-driver does of transporting himself and drove from Liverpool to Walsall pig-market in the heart of Staffordshire.

To the farmer of Wiltshire and North Devon, of Glamorganshire and Carmarthenshire, to whom the choice will be open of sending his butter, cheese, corn, hay, straw, and bullocks, to London or to Lancashire, as he pleases,—who can join with his neighbours in having a cargo of guano fresh from the shipside—who can buy the tiles, timber, iron hurdles, limestone, and coal, wholesale, where formerly he bought it in retail, a new existence, a new course of trade, and source of profit, will be opened. It is to such compensation as this that he must look to replace the protection that he lost the other day.

All the "evidence" proves clearly that the Broad Gauge, with its huge and ponderous trucks, is utterly unsuited to an agricultural district. No company could afford either to maintain the number of hands required at each road station, to move, load, and unload a Broad Gauge cattle van or goods waggon, or to draw daily the dead weight of empty carriages required to supply the uncertainties of agricultural traffic. Of this fact the Eastern Counties Railway affords a perfect illustration. Therefore it is that the Broad Gauge has been, as far as any railway system could be, the BANE of the Western Counties! A

straight line, easy gradients, a rapid pace, and a large carriage, are excellent if not indispensable for pleasure parties, and special expresses. In going to races nothing can equal the Great Western. If the Emperor of Russia should ever be able to spare funds for the construction of the long-talked railway from Petersburgh to Moscow, a line which is intended, like everything Russian, solely for the convenience of the Czar and his soldiers, and which will run, too, through a country of rolling plains, why, there, the Broad Gauge would be in every respect most fit. But the West of England is the very reverse of Russia, and requires, of all things, not huge unwieldy carriages and trucks, but handy waggons, which may, without inordinate trouble or expense, be run into small road stations, and sidings, to which a farmer may send his couple of fat oxen, or his score of sheep, or his load of corn, in conjunction with one or two more neighbours.

Hitherto, of all classes, the agriculturist has least enjoyed the advantages of railway transit: he never can enjoy them where expensive rates and heavy unwieldy trucks prevail; and that is the reason why the Great Western Railway, although running through rich corn-growing and cattle-feeding counties, has created, as yet, so little local traffic. The whole machinery is on too vast, costly, and magnificent a scale.

Were it not for the inconvenience of the Break of Gauge, the cheap little Belgian 3 feet 9 inches Gauge would supply the wants of Somersetshire and Devonshire infinitely better than the Broad Gauge.

At present there is a difference of at least a hundred per cent. between the price of farm produce on the one hand, and coal on the other hand, in different parts of

England. Whenever—and the day is not far distant when that devoutly-to-be-wished-for end shall be accomplished—the uttermost parts of England are, by a cheap uniform, rapid, and punctual means of conveyance brought within a few hours' communication, there will be no sterile land and no unworked coal mines. A regular course of exchange will be established between the agricultural, the mining, and the manufacturing districts flowing on in an even unbroken current. The price of fuel and of provisions —the two great necessaries of life—will be nearly the same at all parts of the kingdom, and at all times of the year. To reach this goal, we must have not less swiftness than we now enjoy, but also punctuality and economy—benefits all-important to miners, farmers, manufacturers, merchants, carriers, and share-holders, —but which, unless nine-tenths of this evidence be false, we can never obtain without National Uniformity of Gauge.

POSTSCRIPT.

WHILE the second edition of this "Brief History of the Gauge Question" was passing through the press, the minutes of the Board of Trade upon the Report of the Gauge Commissioners have been published, and contain the following suggestions for the modification and carrying out of the recommendations with which that Report concluded:—

1. That no line shall hereafter be formed on any other than the four feet eight and a half inch Gauge, excepting lines to the south of the existing line from London to Bristol, and excepting small branches of a few miles in length, in immediate connection with the Great Western Railway; but that no such line as above excepted shall be sanctioned by Parliament, unless a special Report shall have been made by the Committee on the Bill, setting forth the reasons which have led the Committee to advise that such line should be formed on any other than the four feet eight and a half inch Gauge.
2. That, unless by the consent of the Legislature, it shall not be permitted to the Directors of any Railway Company to alter the Gauge of such Railway.
3. That, in order to complete the general chain of Narrow Gauge communication from the North of England to the Southern coasts, and to the port of Bristol, any suitable measures should be promoted to form a Narrow Gauge link from Gloucester to Bristol, and also from Oxford to Basingstoke, or by any shorter route connecting the proposed Rugby and Oxford line with the South Western Railway.

4. That the South Wales line and its branches to Monmouth and Hereford should be permitted to be formed on the Broad Gauge, as sanctioned by their Act.
5. That the Rugby and Oxford line, and the Oxford, Worcester and Wolverhampton line, should be permitted to be formed on the Broad Gauge, as sanctioned by their Acts: that the Lords of the Committee of Privy Council for Trade shall exercise the powers conferred upon them by the several Acts, and shall require that additional Narrow Gauge rails shall forthwith be laid down from Rugby to Oxford, and from Wolverhampton to the junction with the Birmingham and Gloucester line; and that if it should hereafter appear that there is a traffic requiring accommodation on the Narrow Gauge from the Staffordshire districts to the Southern coast, any suitable measure shall be promoted by Parliament to form a Narrow Gauge link from Oxford to the line of the Birmingham and Gloucester Railway.

If these recommendations be carried out, a fair compromise will be effected between the territorial claims of rival companies and the professional jealousies of engineers, while the interests of the public and of individual shareholders will be completely sacrificed. Since the commencement of the present session, Parliament has sanctioned the construction of Railways requiring an investment of eighty-seven millions sterling. The million required for effectually abolishing the Break of Gauge, which both the Commissioners and the Lords of Trade consider a "most serious evil," would have been but a drop in this ocean of prospective expenditure. A more timid tortuous course is recommended, a course which will in the end cost many unnecessary millions, and create countless unnecessary breaks.

The West of England is to be given up to the care of the Great Western Company; a thinly-populated agri-

cultural and mineral district, presenting in North Devon and in Cornwall, engineering difficulties of a peculiar kind, is to be confined to a system which, if it can be cheaply and profitably worked anywhere, can only be worked in a level country affording a large passenger traffic. There is no part of England which would derive so much advantage from free communication with the Northern and Midland Counties, as the West, and this is the district selected for isolation. In certain districts the system of a double Gauge is to be introduced, so that carriages of either Gauge may run upon them, this, according to the evidence of Mr. Brunel and Mr. Stephenson, will involve an additional expense of 2,400*l.* a mile for a single rail, and of 4,000*l.* for a double rail. All engineers are agreed that the two systems could not be worked together without a double rail within the Broad Gauge. Contractors (see Mr. Jackson's evidence) would require an additional 100*l.* per mile per annum, for keeping a road laid on the double system in repair. The number of "points" at which engines are most likely to run off the rails would be increased fivefold, and the complication of the switches, &c., would be increased in an incalculable degree.

If the Board of Trade had been so impressed with the advantages of the Broad Gauge for heavy passenger traffic, which it does not appear they are, as to recommend a Broad Gauge line between London and Liverpool, and London and York, there would have been less ground for surprise, but that they should have patronized in the poorest districts a system of Broad Gauge and double Gauge which involves so enormous and unnecessary expense, *in the face of the universal demand for*

cheap conveyance, trains a penny a mile per passenger, &c., is strangely inconsistent.

The difference to the locality will be the maximum of the tariff instead of the minimum, to the shareholders, an additional 300*l.* a-year per mile for every line on the double Gauge.

With respect to South Wales, it is clearly sacrificed to Ireland; the last sop to the Cerberus of Repeal is the Broad Gauge for the South Wales line. The experience of a century, the evidence of every engineer except Mr. Brunel, and the practice of Mr. Brunel himself, proves that for an undulating tortuous country, where the traffic will chiefly depend on ore, coal, and manufactured iron, a Narrow Gauge is the cheapest and the most convenient. To carry the seven feet Gauge into the valleys where the mines and iron works lie, is in many cases absolutely impossible, but where possible would cost from 6,000*l.* to 8,000*l.* a mile additional, in the tunnels, viaducts, and embankments. The South Wales line will present the spectacle of a railway having at one of its termini a miserable fishing village, at the other a Break of Gauge barring up its route to the Midland Counties, where iron is in most demand, and all along its course Breaks of Gauge wherever joined by roads from the works and mines. In compensation, during the session of Parliament, Irish M. P.s' and Cabinet couriers will dash along by express at the rate of seventy miles an hour.

One city and chief station only has reason to rejoice at this diluted report for uniformity of Gauge. Poor Bristol! whose fate has ever been to sink deeper in the slough of despond, after each vehement struggle for a fair commercial start, the ever credulous victim of

crotchet, and conservatives—of mud and misery—Bristol,—which, in the hopes of improving, gave up to the ignorant rapacity of a small clique of monopolists her fine harbour to be, by absurd taxation, sealed against the commerce of the world,—which has sacrificed as much capital, in a monster steam-ship, fit only for a show, and the monster piers of a never-to-be-executed bridge, fit neither for show nor use, (two more of Mr. Brunel's extravagant whimwhams,) as would have redeemed her port from the *incubi* who crush all sea-born trade, and which, no wiser grown, still warmly patronises a railway system much better adapted for carrying passengers past, than bringing merchandise to her silent docks,—will obtain, in the removal of the Break of Gauge at Gloucester the abolition of the artificial barrier raised up by the Broad Gauge against an interchange with the manufacturing counties. May some of the independent spirit of the North arrive with northern manufactures, and from the abolition of the Break a new and prosperous career date for that ancient and hospitable city!

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NARROW GAUGE EVIDENCE.

Mr. JOHN BRAITHWAITE, Civil Engineer, Chief Engineer of the Eastern Counties Railway; Manufacturer of one of the first Locomotives that ran on the Liverpool and Manchester Railway.

History of Gauge.

1767. Will you favour the Commissioners with your motives for adopting the 5 feet Gauge on the Eastern Counties Railway?

AT the commencement of the undertaking, it appeared that several of the Directors were under an impression that it would be much better to lay down the then contemplated 7 feet Gauge of the Great Western Railway. I considered that it was very unnecessary, involving a very extravagant outlay, and I began to think seriously as to whether that Gauge should be adopted by us, or the 4 ft. 8½ in.; and I then wrote a report upon it. It was very fully discussed at the Board, and it was eventually carried that the 7 feet Gauge should not be laid down. Shortly after it became a question as to what the Gauge should be, presuming it was not to be 7 feet. Having dropped some observations about a variation in the Gauge, the question was put to me, if it was left to myself, whether I would make any alteration in the Gauge. Considering that *we were an eastern district, and that our departure was from London, and not believing that we were all to concentrate in London, and to take our departure from each other's railways, and believing that the eastern portion would be devoted to us, just as we thought the Great Western portion would be devoted to its particular Company*, and knowing the difficulties we had to encounter in 4 ft. 8½ in.; and not looking to ultimately taking a northern road, presuming that the Birmingham line had occupied that

Adopted a new Gauge under the idea that the east would be devoted to Eastern Counties line as the west to the Great Western Railway.

Mr. John Braithwaite.

Arrived at 5 feet Gauge by adding to all parts of engine seeming to require addition.

portion of the country I submitted to the Directors that 5 feet would be a better Gauge. I arrived at that 5 feet Gauge in this way: I found that the locomotive engine was defective in several particulars,—one, as to its generative power, the space we had for boiler room; next, as to the number of wearing parts: I thought that each of them ought to have, if we could afford it, a little more room, allowing a little more wearing surface, but more particularly with regard to the boiler. The tubular system then being very much adopted, it struck me that if we had a little more space between the tubes we should have a more quiet action of the water in the boiler, and consequently less ebullition; and, therefore, with my diagram and my section of my engine, I added to all its different bearings, and I added what I considered sufficient additional space to the tubes, the sum of which gave me 4 ft. 11¾ in., and upon that I assumed that 5 feet would be about the thing. Since then the Gauge has been reduced from 5 feet to 4 ft. 8½ in. As to the policy of so doing, I have very little doubt that it was perfectly right it should be so done, notwithstanding that it involved very great expense. If the intention had been originally to run to the north, we should not have added that 3½ inches, but we should, in common with others, have taken the chance of the very great improvements that have been made in locomotive matters, to which I have myself paid very great attention. I am very happy to say that, although I think that still greater improvements may be made, *the locomotive of this day is not the locomotive of* 1836, *and that, for all purposes for which railways can be wanted, there is additional space to crowd in as much power and more than can ever be commercially beneficial.* The trade generally throughout all the Narrow Gauge lines, from what I see, and from what I have read and heard, is, in all instances, conducted with every possible regularity—that is, so far as the present experience of railway management will permit—but I consider that we are, in respect particularly to the management of our trains, in almost comparative ignorance. I think we are now just breaking

Improvements have given locomotive additional space for more power than required.

Mr. John Braithwaite.

Opinions on Gauge.

into something; there are new ideas daily suggesting themselves. The mind having been hitherto devoted to the construction of railways, people are now turning their attention seriously to the transmission of goods and passengers; and for the convenience either of carrying goods, or for the transit of passengers in particular, I should say that, barring those little notions we had about the *addition of* 3½ *inches, which the improvement of the locomotive has, I think, superseded,* I think that, for the purposes of passengers in particular, the Narrow Gauge is infinitely superior to any other. If the thing were to be made *de novo*, I think then that it might be made 5 feet, because it does give a little more room: but we have found that, although at that time we could not make the engines of that power and dimension to suit a Gauge of 4 ft. 8½ in., yet that some of the bodies of those engines upon our line have been so altered, that those that were running on 5 feet are now running on 4 ft. 8½ in.; which shows the great attention that has been paid, and the improvements which have been made.

For passengers in particular Narrow Gauge superior to any other.

1841. Have you any other observations to add on the general question?

Having adopted a wider Gauge than others, an impression has been created that I am a Broad Gauge man, but I state most distinctly I am not a Broad Gauge man, and I see no necessity for the Broad Gauge.

Sees no necessity for the Broad Gauge.

1851. If I were to adopt any, I should adhere to the 4 feet 8½ in. Gauge.

1852. As being sufficient for all the purposes of commerce?

As being sufficient for all the purposes we can require, and necessarily attended with much less expense in broken countries, with respect to the way itself, in the construction of the line.

1853. In original construction is the Narrow Gauge in all cases less costly than the Broad Gauge?

Yes; particularly in difficult countries. I may

Mr. John Braithwaite.

Curves.

state with reference to the very question that Captain Laws answered, as to curves in rocky districts; it is quite bad enough to curve them down to 4 feet 8½ in. as may be seen by the Taff Railway; for it is the most frightful specimen we have of curves through a difficult country, and engines running at considerable speed, and very far beyond the notion of engineers generally, that they are capable of.

1854. Are you aware that Mr. Brunel was the engineer of that line?

I am.

Uniformity of Gauge.

Change from 5 feet to 4 feet 8½ inches effected without difficulty.

1836. Was the change of Gauge on the Eastern Counties from 5 feet to 4 feet 8½ inches effected without any great inconvenience?

Yes; one would scarcely have known any change was taking place; it was done remarkably well under the management of Mr. Berkley It surprised all parties that it was done so well as it was, considering that it never interfered with the running of the trains.

1837. Could you change back again to that same Gauge, or to a broader Gauge, without more inconvenience?

Perfectly so. I should say there would be about the same expense in the one instance as in the other; it might be done with very great facility.

Cost 1,000*l.* a mile.

1838. Did it cost 1000*l.* per mile altogether, or more than that?

I think that was as near the amount as possible.

1839. Have you any tunnel on your line which will interfere with the increase of Gauge?

None whatever that I consider would interfere with

the increase of Gauge. The whole might be widened without increasing the tunnels. Mr. John Braithwaite.

1840. Would that apply to your bridges also?

Certainly. Our horse-boxes determine the extra width. The space between our rails being six feet, if we were to leave the two horse-boxes the common width in their position as running upon the rails, and widen out the 4 ft. 8½ in. rails to the Broad Gauge, it would not affect the tunnels, or bridges, or viaducts.

1857. Would it cramp your operations a little?

No doubt they would not be so readily used. My notion is, that trucks should be sufficiently large for the traffic; but the more handy the waggons are, the fewer are the hands employed, and the better able are the porters to sort those waggons,—confessing, at the same time, that I think there is more sorting than is necessary.

The more handy waggons are, the fewer hands employed.

1793. Do you think in the 4 feet 8½ inch Gauge you have sufficient space for cleaning, oiling, and repairing the various parts of the engine? **Mechanical Convenience.**

On the present construction of engines, the space is ample, and the complication is much reduced. A variety of parts that required a complication of cranks, eccentrics, and other things, are done away with; and a boy may now with facility clean an engine in an hour, which formerly would take a man a day.

At present a boy can clean in an hour an engine which formerly employed a man a day.

1802. Ton per ton, do you think you work as economically as the Great Western. **Economy of Construction and of Working.**

I have no doubt of it, taking our gradients into consideration. If the capital is to be taken into consideration with full employment for the trains, I have no doubt the Eastern Counties or the Northern and Eastern work equally economical.

Mr. John Braithwaite.

Construction and Power of Engines.

1768. Upon the present system of making engines (and I have no doubt the improvements will go on) they are very superior to what they were; and I do not hesitate to say that within a very few months they will be as much superior as the engines now used are to what were formerly used. The introduction of outside cylinders reduces the complication of the engine materially. There were certainly logical reasons for admitting that the outside cylinders were not so steady as cylinders internally; but, taking all the circumstances into consideration, there cannot be a doubt that the outside cylinders are superior for all purposes as to wear and tear, economy, management, and the means of raising very considerable power, upon a base which, I contend, is quite sufficient to carry anything that can be superposed. But the base is in the one instance as it is in the other, which I rather looked at in the engines at the time of determining the centre of gravity of the engines that were proposed to be used, than the engines we were then using. I took the centre of gravity of the two; and it appeared that, as to its height relatively with its base, if there was any advantage it was all in favour of the Narrow Gauge, or assuming they were equal, it being an isosceles triangle, where it stood on a 7 feet base, or a 5 feet base, or a 2 feet base, the centre of gravity relatively equally high with those bases, was one and the same thing, as far as regards the effect of throwing the engines off by centrifugal effect; and, at the same time, looking also at the narrower base, provided the centre of gravity was as safely placed, was infinitely superior, inasmuch as the more the lines approximated, the narrower they were, the less resistance they had in going round curves, and greater facilities also were afforded for going through broken and difficult country, such as the country I have been looking at lately, and that to which the Commissioners' attention was lately called, on the Manchester and Leeds, which is a work of great ingenuity, and does great credit to those who laid it out.

Mechanical improvements described.

Curves.

Impossible to lay down

As to applying the Broad Gauge in that particular

Mr. John Braithwaite.

Broad Gauge on Manchester and Leeds line.

part, I have examined the country very narrowly of late, to see whether there was an opportunity of getting a Narrow Gauge line by the side or over a certain portion of it, and I abandoned it as being perfectly impracticable.

1770. We began with 6-feet 6-inch wheels. We found by drawing up our centre of gravity they were not so steady.

1771. While you preserved your centre of gravity proportionally low, did you lose a little in velocity?

Speed.

That depended entirely upon the number of strokes the engine would make. At that time the present (to use a strong expression) absurd velocity was not contemplated. I do not think the period is very far distant when a check will be put to that velocity, which is, under any and every circumstance, in my opinion, perfectly unwarranted. You have the means of communicating, by telegraph, any matter of immense importance; and, for commercial purposes, I do not think it is warrantable to travel at the dangerous rate they are now travelling. The other day, on our Northern and Eastern branch, I travelled by the express train, and we ran over nearly seven miles of ground in less than seven minutes.

Accident in using Great Western flanges.

1774. An accident occurred the other day, on the Northern and Eastern, from the flanges of the wheels being made something similar to the flanges of the wheels on the Great Western; but they were of a different shape from ours.

1775. Were those the form of wheels put on the engines altered from the 5 feet to the 4 feet 8½ inches?

The altered engines continue precisely the same, as near as possible. These new engines were lately sent from Bristol, and were manufactured by a party who

Mr. John Braithwaite.

has been in the habit of manufacturing engines for the Great Western.

Construction and Power of Engines.

1776. Were the wheels also sent with them?

The wheels and the engines were sent up complete; they were new engines, with outside 15-inch cylinders and 26-inch stroke.

1777. Was it with those new engines that the accident occurred?

Yes.

1778. Not with the altered ones?

Not with the altered ones.

1779. Do you find that the outside cylinder has a more yawing motion than the inside cylinder?

Practically, certainly not. In the first instance, in 1836, I constructed four for our ballast engines, and with those we have attained a speed of 65 miles an hour. We have tried a variety of experiments there; we have tried what we could do with regard to having fixed objects upon the engine, intersecting a point upon a well-constructed portion of our line. If there has been any difference at all, it is in favour of the outside cylinder, and that was in consequence of our taking great care to have everything as perfect as possible.

Works outside and inside cylinders on his line.

1780. Have you now both descriptions at work on your line?

Yes, and they work remarkably well.

1781. Are you yourself a manufacturer of locomotive engines?

I have not been for the last ten years.

1782. Do you still turn your attention to the subject?

Very much. I am now taking out a patent for a new engine.

1785. Do you think that increased length of boiler or heating surface gives the increased power that you hoped to derive from an increased Gauge?

Considers increased length of boiler gives increased power.

No question about it; but my individual impression is that they are too long, from the circumstance of the spread of the axle involving retardation or greater resistance. The more they are apart, the nearer they approach to one very material difficulty that I have always suspected on the Great Western in what they call their seventy-fours.

1786. Are you not of opinion that the increased length of carriage gives greater steadiness on the rail?

And increased steadiness of carriage, within certain limits.

There is not a doubt about it, within certain limits. But if it is to be so increased in length as to be retarded by all the little inequalities of the line, the one would be as bad as the other.

1794. It would be infinitely better to have two engines than to concentrate the whole of the power on a certain number of wheels that can practically only run on a good rail. The six-wheeled coupled engine is now the fashion. Unless all the peripheries of the wheels were equal, there must be a retarding force; but when we come to six wheels, it multiplies the difficulty.

1796. Are there any engines now made with wheels revolving on the axle?

I have never heard of any.

1797. But there were instances of one wheel being left loose?

One, I think, but that was abandoned?

1799. Do you think we have attained the limit of useful power in our engines?

I have very little question about it, looking at the

Mr. John Braithwaite.

thing purely (as I do) in a commercial point of view. *If the object were that all the world might leave London in the morning and come back at night, you would want magnificent gradients such as on the Great Western with the Broad Gauge,* so that there might be sufficient power, if concentrated in one focus, to take the whole of that traffic and bring it back again. We know the general commercial traffic seldom exceeds 50 tons, therefore you have sufficient power for 200 tons, and only require to draw 50 tons, I consider there is a very considerable sacrifice of power; inasmuch as the engines with common loads on the Great Western weigh 20 tons, there are 10 tons of dead weight always carried at a very considerable cost.

For all the world to leave London in the morning and return at night Broad Gauge required.

1804. In what items is the expense most felt, comparing the quick train with the slow one?

In the wear and tear, and fuel. From the rapidity with which they travel it is impossible that the cylinders of the engine can have time to fill themselves, therefore there is vast expenditure of power which is never felt by the engine.

1805. Do you happen to know the maximum speed of the express trains on the Northern and Eastern line?

I have travelled 62 miles an hour between Broxbourn and Waltham.

1806. With what load?

I should think there must have been at that time about 60 tons. The carriages on the Northern and Eastern are heavier carriages. We run with four wheels, and they run with six wheels.

Travelled 62 miles an hour with 60 tons.

Construction of Roads.

1808. Have you at all observed the relative advantages of the transverse and the longitudinal sleeper, so as to give an opinion upon that point?

I have already stated my opinion that in several instances the transverse sleeper is superior to the longitudinal sleeper. The sleepers are more easily repaired,

Mr. John Braithwaite.

and all Narrow Gauge lines are in better condition, as far as regards running, than the Broad Gauge. It is not six weeks since I travelled on the Great Western line, not in an express train, and on certain portions of the line they travelled at the rate of 40 and 45 miles an hour; the oscillation was insupportable. A portion of the line had been relaid, and possibly it may have been more out of order at that time than it usually is. But I can state positively that all my experience has shown there is more oscillation on the Great Western than on the Narrow Gauge lines.

Thinks more oscillation on Broad than Narrow Gauge.

1809. Might not that have arisen from the particular carriage in which you were riding?

We changed our carriage and experienced the same oscillation. Part of it is better; but whether there is more play or whether they have not the ready means to pack under their longitudinal sleepers that we have, I cannot say. When properly arranged, no doubt the train would run as well on one road as the other, still I think we have the means of more readily repairing the road than exists on the longitudinal system.

Break of Gauge. Remedy.

1844. Have you seen the apparatus put up by Mr. Brunel, at Paddington, for transferring from the Broad to the Narrow Gauge?

Yes.

1845. Does not that seem very ingenious and simple?

Perfectly simple.

1846. By an increased number of such contrivances, might there not be a change effected of the whole train without great loss of time?

By multiplying those accommodations you might do it in any time required.

1847. Merely involving an expense chargeable on the commodity?

Yes.

Mr. G. P. Bidder.

October 25th, 1845.

GEORGE PARKER BIDDER, Civil Engineer, Engineer of the Norfolk and several other Railways.

Convenience of Passengers, Goods, and Carriages.

4117. I prefer 6 wheeled carriages for passengers. I introduced 6 wheel trucks for goods on the Northern and Eastern, but my recent experience induces me as regards goods traffic to revert to the 4 wheels. We found they were so unwieldy in the stations, they are long, and require heavy and long turn tables, and when they are not loaded they are carrying so much more dead weight. On the Yarmouth and Norwich we found them a very great inconvenience, and we have it under contemplation to convert them into parcel trucks, and other trucks for light goods to run with a passenger train. All our present trucks are with 4 wheels. For the same reason as I have stated with regard to the Norfolk line, I think the 6 wheeled truck of the Great Western is objectionable. I can see no differences in the circumstance. We certainly have found a great inconvenience there from the increase of the porters and labourers at the stations which is a cost to the commercial man.

Large trucks inconvenient, unwieldy, not to be filled.

4133. As regards convenience of passengers, the breadth of the carriage is a matter of taste. I myself would rather ride certainly three abreast, or even two abreast, than four abreast. In winter I have found the double compartment a great inconvenience when I have been in the compartment furthest from the platform side, I have had to disturb those whom I have had to cross when they have been making themselves very comfortable. On the other hand, I have been disturbed by others under the same circumstances; and certainly on the Birmingham and Grand Junction lines the old

Carriages for passengers two a-breast preferred.

fashioned mail carriages, two abreast, are most sought after, and most generally filled. Mr. G. P. Bidder.

4134. They should be a little larger, should they not?

They may be, but I am only talking of the question of having more than three abreast. All the new carriages are made wider. I do not allude to space for passengers, but to seating more than three or four abreast in a carriage. As regards the goods waggons, it seems to me most material, especially when you multiply the net work of railways, where you have branches extending through agricultural districts, that you should have waggons appropriated to their convenience. At particular stations they will very often be only half loaded; and as to sending through an agricultural district great heavy waggons weighing four or five tons, and requiring large turn tables to turn them, my own feeling would be decidedly in favour of a more handy truck. Small waggon best for agricultural traffic.

4135. Are you of opinion that, with the present perfection of the permanent way, it is desirable to aim at higher rates of speed than those that are now used? **Speed.**

No, and it does not appear to me that very much higher rates of speed would be required. What I think would be required would be the multiplication of trains, because there would be much more convenience in my apprehension from giving frequent departures, than from running particular trains at a very high velocity. Higher speed than present rate not required.

4124. As an experienced railway man, can you at all account for the great increase of cost which Mr. Gooch says exists upon the Narrow Gauge lines for the locomotive power of the goods trains, the cost upon the London and Birmingham **Economy of Construction and of Working.**

Mr. G. P. Bidder.

and the Grand Junction being double what it is upon the Great Western?

Does not believe Mr. Gooch's calculation of comparative cost of two Gauges.

I only saw Mr. Gooch's evidence yesterday; I read it last night, and as an actual comparison of mileage, I do not believe it. It seems to me the simple way would be to ascertain what is the actual cost per mile, at which the same engine on a broad and narrow line can run, including wear and tear, fuel, and interest on capital, and what the effect of that engine would be; then you have the means of ascertaining the comparative cost apart from all other circumstances which we know affect the expenses.

4153. I have no experience of the repairs on the Wide Gauge. I know what the repairs are on the Narrow Gauge, and I know that except what repairs are affected by a series of bad curves on the line, they are very slight, but as I know that the repairs are very much augmented by bad curves, and as I feel satisfied it must be a fact that a wide carriage, or a wide engine, must be subject to greater torsion from curves than a narrow one, I would say, as far as my opinion goes, I cannot believe that it is possible that the repairs of the Wide Gauge carriage and engines can be so little as of the narrow. I have no experience of the repairs on the Wide Gauge, but I do know that on a bad curve line the repairs are very much augmented on the Newcastle and Carlisle; the repairs of the engines as compared with the North Shields, are about 250*l.* per engine per annum.

Curves.

Repairs increased by curves.

4154. May not that result in some degree from the line having been less perfectly made, which is the fact?

No, it is in those parts of the engines, not the wheels, which would be affected by that, but the side rods, those parts of the engines affected not by the state of the road, but by curves. That fact was investigated with some care by Mr. Nicholson, of the North Shields Railway, and he has all the figures; I

cannot give them myself, but he could give you a table showing the actual parts of the engine upon which that increased cost took place. Mr. G. P. Bidder.

4121. Do you know at all what is now the highest speed that is used on the Northern and Eastern? Speed.

I do not know what is now used; in the express train in which I have frequently travelled, the speed is 46 miles an hour realised, including stoppages.

4123. The time tables do not give so much as that?

No, the time tables give 45 minutes from Shoreditch to Stortford, that is 32 miles, that would give a speed of 43 miles an hour—42 and a fraction, but they generally arrive there in time to get the tickets taken and discharge passengers in that interval.

4133. From your long experience and the consideration which I am aware you have given to the subject, are you disposed to give a preference now in a new country to the Broad or the Narrow Gauge, or some intermediate Gauge?

Opinions on Gauge. Points of comparison: safety, convenience to passengers, economy to merchandize.

It seems to me that in the question of Gauge there are four material points which ought to decide the question. The first is as to safety; the next is as to the power of the engine; the next would be what class of carriage which would be most convenient to the public, and the last the waggon which would be most economical and found most generally useful. Now, as regards safety, I must confess that I cannot see that between the two systems there is really any difference at all. I admit that on the one hand you would have somewhat more difficulty in capsizing a broad wheeled carriage; then on the other hand, I think you must admit that a broad wheeled carriage has a greater tendency to run off the line; it must have the effect as regards curves of diminishing the proportion. I

Mr. G. P. Bidder.

do not mean to say that I would lay any stress on that objection. Mr. Gooch has quoted an experiment, an observation at Bristol of a carriage that went at 40 miles an hour round a curve of 600 feet radius. I have calculated the centrifugal force, and that is rather less than one-sixth of gravity. Now, supposing the centre of gravity to be 5 feet, which perhaps it may be on a Narrow Gauge carriage, that carriage

Curves.

would travel round a curve without capsizing, supposing the curve was half a mile radius, at about 130 miles an hour before it would capsize. A Broad Gauge carriage would travel on the same curve probably at between 150 and 160; that is what theory would give. Both those speeds appear to me not likely to be attainable in practice, and not likely to be required. Therefore I think, in point of safety as regards the question of Gauge, it really ought to be put on one side, and though a narrow wheeled carriage has not the same tendency to run off the rail, I think there is so little tendency in either, that, as regards safety, there really can be no material question between them. Then the next point is the power of the engine. At present we can produce a narrow engine evaporating the same amount of water as on the broad.

Speed.

4135. With the present perfection of the permanent way, is it desirable to aim at higher rates of speed than those that are now used?

Yes; after you have attained a speed of 40 or 45 miles an hour, a saving of time by the increase of speed does not go on pro ratâ, it is very much diminished. You save a great deal of time from 20 miles an hour to 40 miles an hour, but an increase from 40 to 50 miles an hour is not of that importance? I think the only danger from increase of speed arises not from the actual travelling but from the interference of other lines. For instance, if you take the line of the Great Western, and the London and Birmingham, they would be connected by branches at various points; you cannot have high rates of speed

Increase from 20 to 40 miles an hour more important than 50 to 60.

between the termini without the necessity of very few stoppages, and therefore you must go through a great number of stations at a very high rate; there is where there would be the danger, not in the travelling. I do not believe there is any danger in travelling at any speeds that we are ever likely to attain. With the present state of the permanent way where the rails are 70 to 75 lbs. weight. I believe upon that system of rails you might travel certainly 70 or 80 miles an hour. I do not see any danger except where the curves are sharp, but there would be a practical limit to speed from the difficulty of getting the engine drivers to diminish their speed at certain points. I do not think the express trains can be introduced to any extent, with any safety, *without the electric telegraph to forewarn their progress, and to forewarn them of any impediments in their way.*

Mr. G. P. Bidder.

Expects no danger from speed except on curves.

Express trains dangerous without telegraph.

5509. Are there any observations which you wish to make in addition to your previous evidence?

Comparison of the two Systems.

With reference to the waggons it occurred to me to mention a reason why the Narrow Gauge waggons are more desirable, and it is a reason which I think is growing daily, and which now on the Norwich and Brandon is experienced materially, that is with reference to the road stations. On that line we cross a great many country roads on a level, and we place there very small sheds, we have sidings into those sheds, and we appropriate them for the conveyance of coal in one direction to farmers in the district, and taking away their corn and their produce in the other direction. We are also carrying sidings to some mills that we go near. Very frequently at those stations they have a load for one waggon, or perhaps two-thirds of a load and we take it away, but if we had very heavy waggons we should have some difficulty in moving them in the bulk, because there is only one man there, the gateman who looks after it, and of course, excepting the men who go with the train, there would be no other hands

Why small waggons most convenient.

Examples.

Mr. G. P. Bidder.

Break of Gauge.

available for that purpose. Also with reference to branches; we are constructing a branch from Dereham to the main line which will be extended to Walls, and in that district we are providing carriages which take first and second class passengers with the view of enabling parties to be conveyed to their destination in one carriage to avoid the inconvenience of having to shift their luggage, and getting out of one carriage to the other. The principal traffic from those branches will be towards Norwich, and the few passengers going towards London will probably have to get out and change their carriages where they join the main line, but the local traffic, which is by far the most numerous, we propose to carry throughout in one carriage. I am quite aware of the observation that when you stop at stations, say Wolverton or Birmingham, you get out of your carriage and get in again, and it has been stated that this is tantamount, and more than tantamount, to changing the carriage. Now I think it is a very different thing altogether; in the one case you merely take care of yourself, and in the other case you have to look after your luggage. I have found that, and I have known parties complain of it bitterly at Birmingham, when the carriage has been taken off there, and has not been going through to Liverpool and Manchester, the whole of a person's time has been occupied in knowing where to place himself. Then I think Mr. Brunel stated that the stations on the Narrow Gauge were more costly, because the carriages holding three abreast instead of four, the train was so much longer on the Narrow Gauge than on the Wide. Now in the bulk of our stations, certainly all the road stations, the only difference it could make would be in the platform, because the booking office must be the same, the sidings must be the same, and there must be the same accommodation of turn plates. The saving of cost, supposing it were effected, which I doubt, in altering the length of platform, would, in my opinion at least, be more than met by the extra cost in laying the larger turn plates, and the apparatus necessary to accommodate the larger carriage. But in order to establish Mr. Brunel's posi-

Passengers object to change carriage.

Answers Mr. Brunel's calculations as to cheaper stations on Broad Gauge.

Mr. G. P. Bidder.

Economy of construction and working.

tion it is necessary to do this, to show that although they have the means of carrying four abreast, whether with the chances of having carriages partly empty and unequally loaded, they do in point of fact get more passengers for a pair of wheels than they do on the Narrow Gauge. I have seen returns (I cannot speak to it myself) by which the contrary result has been shown, but I am quite certain that in any event the cost of stations cannot be affected by that circumstance.

5519. It was stated by Mr. Brunel that the wider engine and the wide carriage, in fact, need not be stronger in their parts than the narrow. Now, that is entirely different from anything which I can conceive, and I cannot conceive a reason for it. They state that, if you take a Narrow Gauge waggon, cut it in two and interpolate the width requisite to adapt it to the Wide Gauge, if you lengthen the axles and the framing it will be quite adequate. Now, there must be more torsion, there must be more labourage; all the shocks and jerks occurring to a waggon travelling on a railway must act with greater effect on the Wide Gauge than on the Narrow. Imagine, instead of 7 feet, 7 yards, do you suppose it would only require the same strength of cross bearers as on the Narrow Gauge? Besides, as to the springs calculated to take the shocks, the result of the mass into the velocity, it is quite clear their power ought to be as the gross load of the waggon.

5520. I think he admitted that?

I do not perceive it.

5521. The other certainly is not consistent with the usual laws of materials?

It appears to be entirely at variance with them.

5551. Have any accidents come under your knowledge of engines or of carriages getting off the line, attributable entirely to the narrowness of the Gauge?

I have never known one.

Mr. G. P. Bidder.

Break of Gauge.

Transfer of goods by mechanical contrivance, not practicable.

Example: Break between London and Edinburgh.

5559. The Break of the Gauge, and the transit of the goods at a station like Rugby, or any other place where there is a large traffic, I cannot help viewing as a difficulty exceedingly formidable in itself. I can easily conceive mechanical contrivances, of various sorts, for effecting that alteration; but when one sees the evolutions at a goods station, the uncertainty of the quantity, and perhaps of the times of arrival, I am quite certain, if you look at it only as a mechanical problem, you do not view it in a practical light. You must consider the number of men that will have to be kept, because you must have sufficient at all times to meet the largest train, the chances of breakage and pilfering, and then the necessity of keeping a large stock there, I regard as inevitable. I will take the case, which has been put by one of the Commissioners, of having a main line from London to Edinburgh, with a break in the middle. If you had your breaks in the middle, experience would show you in time the surplus stock you would have to maintain in London or in Edinburgh, to meet the inequalities of traffic, there would be a certain surplus stock in London, and a certain surplus in Edinburgh, say 100 waggons in each place, that would be a surplus stock altogether of 200 waggons. But if you broke the Gauge, we will say at York, you must have 200 additional waggons there, because you must have 100 waggons to meet the inequalities of the Narrow Gauge traffic between London and York, and you must have 100 Broad Gauge waggons extra to meet the inequalities of the traffic between York and Edinburgh; for the inequalities would apply as well to York as to the traffic throughout the whole line; therefore, you must of necessity have double the surplus stock.

5560. If you had a station where you changed midway between the two, a carriage might run down from London to the midway station, and return with a load coming from a more distant one?

Certainly.

5561. How does it involve the necessity of doubling your stock? Mr. G. P. Bidder.

The surplus stock, not the running stock, you have a trade, and you find the more you extend it the more the inequality increases. On market days, for instance, you provide an enormous stock for the cattle and sheep, and all those things going to market, and even with the ordinary traffic in goods on railways, manufacturing goods and coal, you find that at one season of the year there are, say 2000 tons a day, and all going in one direction; and, at another season of the year, only 1000 tons a day, and perhaps that is divided into two directions, so that you must of necessity keep a certain surplus stock to meet those inequalities, and that, I have supposed, requires you to keep 100 surplus waggons in London not running, and 100 surplus waggons in Edinburgh. If you break the Gauge at York, you must have the same surplus there as at the two extremities, because the inequalities may arise there in the same way. Irregular flow of goods traffic requires large extra carrying stock.

5562. In fact, that would apply to every station where you had a break?

Certainly. Then, even with the running stock you must have a larger stock; because, suppose it took 20 hours to go from London to York, and the trans-shipment took 10 hours, instead of being able to use the same waggon every 40 hours there and back, you must use it only every 60 hours; therefore, whatever space is consumed in the trans-shipment of the goods in the proportion which that bears to the time which the train is running, you must increase the amount of your running stock. Extra locomotives.

5563. But you do not apprehend that the trans-shipment of those goods will take ten hours, or five hours, or even three hours?

That is a question of cost. For instance, here is a train extending every day,—they multiply trains on the London and Birmingham, and find they must increase the extent of them. As there may be a train of 600 or 700 tons, which has been the train they have frequently Time of trans-shipment a question of cost.

Mr. G. P. Bidder.

had on the York and North Midland, and those lines take 500 tons, that is, 100 waggons; if you were to take ten hours, that would be ten waggons per hour; now, it would take a great many men to trans-ship those in any time you like. Suppose you have another train coming there from the other direction, you may have two or three trains of 500 tons each in the station by chance, and you must be prepared to meet it or impose on that train a long delay. I do not believe that if there were a break of Gauge, mechanical contrivances would ever be employed, experience would show the greater advantages of doing it all by hand. In the first place, from the extent of those contrivances, their getting out of order, there being something lost or misapplied, and not being in the exact place, you would find it very difficult with the extent of sidings which the station would require, and if you controlled all by that mechanical arrangement, it must be exceedingly expensive and very costly. I believe you might try the experiment for a field-day, but the practical effect would be, that it would be done by hand excepting the very heavy goods.

Danger of mechanical contrivances getting out of order.

5564. We have been told by an engineer of great experience that if the amount of the traffic were sufficiently considerable to justify the erection of mechanical arrangements, he would undertake to trans-ship any quantity of coals brought, provided there were enough for the train, at 1*d.* per ton.

I do not believe it will ever be done. I do not believe that anybody would say that, who had the practical working of the thing. I can conceive mechanical contrivances with which a man may satisfy himself from calculations on paper undoubtedly, but as to its being done in practice I do not believe it would without a considerable degree of inconvenience; I believe that experience will show that it will never be attempted. I know in simply lowering goods what the inconvenience and annoyance and cost of keeping it up is, and I could judge from that, what the effect would be of shifting a whole train.

Paper calculations of transfer not answer in practice.

Mr. G. P. Bidder.

5568. If for the lines north of Norfolk it was determined to adopt the Broad Gauge, and there were a change of Gauge, do you think the goods trains and other trains coming could be trans-shipped by lifts?

I cannot say what could be done; I am sure it must occasion a good deal of expense and inconvenience.

5569. And detention?

The agricultural traffic will become enormous when convenience provided for it.

Yes, and the goods traffic of the country which will come upon railways we have no notion of. The agricultural traffic will become enormous (my observation in Norfolk assures me of that) when the requisite conveniences are provided. The quantity of goods and the variety in the description of goods, which will have to go through those great meeting points will be such that I do not think any of us can form an adequate notion of it, and the restriction that the Break of Gauge will place upon it will be such as to render it a question whether it will not check the whole thing. I am convinced that we shall have to carry very much more, and shall be able to charge a very much lower rate for agricultural produce than at present.

Uniformity.

5571. Would the tunnels admit at present of the passage of Broad Gauge waggons?

It is possible you might squeeze them through, but I do not think it would be proper or safe to us.

5572. Safe in what respect?

You would have such a little space.

5573. But you have space enough?

Dangerous to pass Broad Gauge through Eastern Counties' tunnel.

You might squeeze a waggon through possibly. I have never made a diagram of it, but as Mr. Brunel stated, I think that he had 11 feet, and as our tunnels are 22 feet, that is the absolute width, therefore a waggon would shave past it. But although mechanically it may

Mr. G. P. Bidder.

be accomplished, I do not think practically it ought to be allowed. I do not believe that you ought to have a tunnel anywhere of less dimensions than to admit of space for a man to stand against the side or in the middle between the two trains, in case he is caught there, because you must have men in the tunnels as well as anywhere else, and then as people will put their heads out of carriages, some provision ought to be made for that.

Not safe to lay down Broad Gauge in narrow tunnel.

5576. If you preserved your present width of every thing, and only had the Broad Gauge, then could you do?

Yes, by merely widening the axles.

Opinions on Gauge.

5579. On the whole, do you not think it would be an advantage if all the railways were upon the 5 feet 3 inch Gauge?

Does not believe extension of Gauge would add to useful power of engine or convenience of carriage.

I do not think we should get a more powerful engine, because our engine, as I said before, is of sufficient width: we certainly should not make a larger boiler, we might add a little to the fire box. But we are doing that now by making them a little longer instead of wider, with the new engines that are coming out. Certainly as to convenience there would be nothing in the carriage worth talking of. The new carriages of the London and Birmingham are quite high enough, and quite wide enough. I do not think I ever heard a person complain of them, therefore with regard to passengers it would be of no advantage. With regard to goods, you would get nothing I am sure of any consideration, and as regards the engine, if our outside cylinders are not objectionable, we certainly do not require another inch for the construction of the engine. The lines on the North Midland lines are certainly larger than they are on the Great Western.

Mr. W. Fernihough.

October 27th, 1845.

MR. W. FERNIHOUGH, Superintendent of the Locomotive Department on the Eastern Counties Railway.

Power and construction of engines.

4238. Take the heaviest load that you work upon the Northern and Eastern Railway; do you imagine that the heaviest loads that the country requires upon that line can be worked by engines of the 4 feet 8½ inches Gauge to the utmost advantage?

The heaviest loads the country requires can be worked on the Narrow Gauge when advantage taken of certain points.

I think they can, under certain circumstances, that is, when advantage is taken of all those points which may be adjusted to the Gauge in a powerful engine upon the Narrow Gauge. I mean to say, that a more powerful engine may be made upon the Narrow Gauge than has hitherto been made, and that the narrowness of the Gauge need be no obstacle to increased power beyond what they have now.

4239. Do you imagine that, for the traffic of your district, a 7 feet Gauge would be preferable?

The seven feet inconvenient on sharp curves.

No, I do not think so. It would be extremely inconvenient in the sharp curves; for on sharp curves there is more friction and grinding on the Wide Gauge than on the Narrow, because, of course, the outer rail being so much longer than the inner one, there is more slipping.

4249. What is your opinion of the relative advantages or disadvantages of outside cylinders as compared with inside cylinders?

I think when an engine with outside cylinders is judiciously constructed, it may be made a better engine than the inside cylinder engine on the Narrow

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Gauge. But it is very easy to make a bad engine with outside cylinders.

4250. On the whole I think the outside cylinder better suited for the Narrow Gauge than the inside cylinder.

4264. Length of the boiler tends to produce a jumping or a rocking motion, when injudiciously placed upon the framing and wheels. I think the boiler might be so placed as to obviate that motion.

Speed. Safety. Curves.

4296. The Great Western people naturally aim at a much higher velocity than they have already attained, and they assert that the narrower carriages cannot run with safety at the same speed or carry the same loads, inasmuch as they cannot construct engines of the same power without being dangerous?

I completely dissent from that.

An engine steady at 60 miles an hour.

4297. I have some engines under my care at this moment that, at any speed you can put them to without a train, are as steady as at 10 miles an hour. Those engines have, for the satisfaction of General Pasley, to whom I wished to show the fact, been run at a speed of above 60 miles an hour, and at that speed they were steadier, and apparently safer, than at 10 miles an hour, owing to the application of buffers between the engine and tender, which have a very great effect in producing steadiness.

4357. Do you consider that an increase of the Gauge would afford you greater facilities for augmenting the power of your engines than you have at present?

The power of the engine is limited by the strength of the rail; and if you still retain the six wheels, you cannot, with the present plan of engine, get beyond a certain power; the rails would not bear it.

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4373. Do you think that increased power might be better attained by a wider Gauge, or by the adaptation of the engines to the Narrow Gauge?

I would rather adapt the engine to the Narrow Gauge.

Sinuous action, less on Narrow than on Broad Gauge.

4283. I think our loads run as steadily as I have seen them to run upon the Wide Gauge, because the principal source of unsteadiness is sinuous action, and that sinuous action is less upon the Narrow Gauge than on the Wide Gauge. I think we have sufficient width to give perfect safety.

4301. I think, with respect to curves, the Narrow Gauge has great advantages; it enables much sharper curves to be run over with safety, and without those evils which are the consequence of curves upon a Wide Gauge, having to keep engines in a high state of repair to be safe on the rails, and to keep the road. The axles also, I think, are more likely to stand the work on the Narrow Gauge than on the Wide, being shorter and stronger; the atmospheric resistance is also less, and that is a very important element with high speeds.

Accident in consequence of new road.

4308. Our speed is not great now; we only run an express train upon the Cambridge line; the speed is probably about 40 miles an hour, but when the line was opened only to Bishops Stortford, 30 miles, the express train then maintained a very high rate of speed; it was often done at 55 miles an hour the whole distance. After the accident on the Cambridge line, when the engine ran off the rails at Littlebury, the speed was reduced upon the new part of the line, and as the new part of the line constituted the greater part, it would have availed nothing to have run at excessive speed upon the old portion. We have several severe gradients upon our line.

4355. It is assumed by the Great Western, that they have greater steadiness and greater safety by

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carrying the whole of their load within the framing. There is less rocking motion naturally?

Rocking motion not dangerous.

As I said before, when the arrangements are good, and the proportions good, and the carriages properly screwed up together, then I do not think that rocking motion has any danger attached to it; it is the sinuous motion that, I think, is the most dangerous, and that is greater on the Wide than on the Narrow Gauge.

Comparison of the two systems.

4378. Then you think you can attain by a proper engine the same speed as can be attained by the Great Western, supposing they carry out their principle to its highest point?

Will back an engine to run on Narrow Gauge as fast as any one would like.

If they were to run a battle between the two, there being introduced first one improvement, and then another improvement, no one could say who would get to the highest point first; but I think this, that I can back an engine on the Narrow Gauge to run quite as fast as anybody would like to go with a train, as fast as would be safe, on account of gates, crossings, &c., which would probably be found to be about 70 miles an hour. I think I can make an engine capable of attaining 70 miles an hour with a train, and working regularly with a load of moderate weight; but I do not think there is any engine in existence that would do it now.

4300. Whatever advantage may be in the case of the Great Western line, you do not think that a system of general application?

Does not think the results of the Great Western pay the cost.

Taking the whole affair together, I do not think the increased expense of making and working are compensated for by any advantages that they possess over the Narrow Gauge. I think the full efficiency of the Narrow Gauge has not yet been brought out.

4360. If it were now a question to determine the Gauge

for the whole country, what width should you, as a practical man, be disposed to give, so as to attain the greatest number of advantages with regard to safety, speed, and profit, looking at the thing both as a matter of safety and as a commercial matter?

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In proposing a new Gauge, I should not fix on an odd number of inches, because I could not give any reason for a half inch one way or another. Very probably I should think 5 feet the right Gauge in that case, deriving it from the practice of common road vehicles.

In a new Gauge would probably fix on 5 feet, the usual width of road vehicles.

4307. One point that influences the working expenses on the Great Western is that they have extremely perfect carrying stock engines and carriages, and probably the management has been more perfect than on most other lines in times gone by.

Mr. J. Hawkshaw.

November 4th, 1845.

Mr. JOHN HAWKSHAW, Engineer of the Manchester and Leeds, Manchester and Bolton, and the Ashton, Stalybridge, and Liverpool Railways, (*employed in* 1838 *by Great Western Shareholders, in conjunction with Mr. N. Wood, to report on Broad Gauge.*)

History of and Opinion on Gauge.

Laid out Leipsic and Dresden Railway, 70 miles long, upon the Narrow Gauge.

5587. In connection with Mr. James Walker, I laid out the Leipsic and Dresden Railway; the length of that line is 70 miles. It is upon the 4 feet 8½ inches Gauge. It was the first railway in that district, so I was not at all bound to that Gauge by any other previously formed railway: several others have since been constructed branching out of it. We were not restricted to that Gauge by the Government; I think it was left very much to our own choice; they had no disposition to change the Gauge, and we had no disposition to advise a change.

5607. We suppose you are prepared to admit that, if the Great Western chose to avail themselves of the whole width of their Gauge for the construction of the most powerful engine, they would attain greater power than can be attained by the Narrow Gauge?

No doubt it would be a larger machine altogether; and then the question is, whether the machine is not now quite large enough, looking to the extension of the system. I think that the extension of railways, an evident thing now, has very much changed that question. Some years ago it was considered that the traffic of the country might be sent along main trunks of railway, and that two, three, or four large lines would subserve the traffic of the country. Now, it is quite clear that those anticipations are likely to be disappointed,—that the fact will be that railways will extend themselves all over the surface

Formerly it was considered that two, three, or four large lines would serve the traffic of the country.

Clear now that traffic will be split up into various streams.

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of the country; consequently the traffic will be split up into various streams, and will become a kind of intermediate traffic, requiring constant interchange and connection at various points; and, therefore, the question of a large Gauge and a large machine, and so on, to my mind, is a very much simpler one than it was five years ago. I think there is very much less occasion for great power in one direction.

Prospects of system rail.

5608. I think the absolute necessity of extending railways, now that every road is to have a railway, rather goes to show that it is not wise to make those railways of very large dimensions. The question is not so much what is best for one large trunk railway running through the kingdom, as what is best as a system to be applied to the whole kingdom; and any arrangement which neglected the extension by branches to every town and every village of importance, would, I think, be detrimental to the country.

Not the question what best for one large trunk line, but what best for the whole kingdom.

If question were entirely open, would adopt a Narrow Gauge.

5609. Supposing the question of the Gauge were now entirely open throughout the country, I have no hesitation in saying I should be disposed to adopt a Narrow Gauge; of course, when I say a Narrow Gauge I do not mean 4 feet 8½ precisely, because its being 4 feet 8½ is an accidental circumstance.

Speed.

Express train on Manchester and Leeds run 60 miles in 1h. 56 m.

5601. The express trains on the Manchester and Leeds Railway run 60 miles in about one hour and 55 minutes, but then they have a good many stoppages and inclined planes, which make the speed about 45 miles an hour; that is the running speed.

Trains which carry on every-day business, more important than express trains.

5611. I must confess that I do not consider running express trains nearly so important a thing to the traffic and commerce of this kingdom, as the running of the trains which carry on the every-day business; it is only one man in fifty that cares about being hurried along at that speed; the mass of the people do not care at all about it.

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Breadth of Gauge cannot increase velocity.

5658. There is no doubt at all that if you put the Broad Gauge engine upon the Liverpool and Manchester line, it will run as fast as upon the Great Western. The breadth of Gauge cannot increase the velocity; as an abstract question, there would be greater velocity with no Gauge at all.

Power of Engines.

5605. Have you discovered any practical inconvenience in the outside cylinder engines?

Prefers the outside cylinder engine.

No; there is perhaps a little more side motion, at least I fancy so, though I think it very slight; it has been very much less perceptible since we have lengthened those engines; but I very much doubt whether it is not more than compensated by other advantages, the gearing is exceedingly simple, and therefore keeps in order and repair very well; it can be got at easily. It is an engine which, if it had as much attention bestowed on upon it as the others, would be an excellent engine. My experience makes the repairs of the outside cylinder engine decidedly less than with the inside cylinder.

The rails are crushed beneath the present weight of engine. Cannot be made heavier without destroying rail.

5646. I would just mention one point which appears to me to limit the size of engines very much. We have found now that we have got to the extreme size and weight; the rails are all crushing beneath the present size of the engines. I do not think the weight of the rails has much to do with it; the upper surface crushes off. It, in fact, squeezes out, and it strikes me that that will be an effectual limit to the size of the engines; you cannot make them heavier without destroying the rail. The material will not bear any more pressure.

Prospects of Railway System.

5609. I am quite sure that the working of railways will become a very different matter, in course of time, from what it is at present; that, instead of collecting traffic, and carrying it in very large

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heavy trains, the perfection of the system will be to have much lighter and more numerous trains. I may state that, in my own practice on the Manchester and Bolton Railway, I have greatly increased the trains each way; and I do not, and shall not feel satisfied until, on lines like that in the manufacturing districts, a time-bill will be unnecessary, and you will be able to go to the station as you look out in London for an omnibus, and be sure that you will get a train within ten minutes of wanting it. There should be no necessity to seek out time-bills, and find at what hour the train will go; and my impression is, that that will ultimately be the practice of working railways. I believe it will be for the advantage of the companies themselves very much, and certainly to the advantage of the public.

The perfection of railway system to have light and numerous trains. No time tables.

Like omnibuses in London.

5612. I am persuaded that expense of working a line upon the principle I have just stated, would very little exceed the present expense, and give increased accommodation to the public; but if the universal Gauge were a large one, while you might prove it to be desirable to run very frequent, and therefore light trains, if you were compelled at the same time to run very large engines, there would be a very great difficulty in the way of working the lines in that manner.

Expense would little exceed present system.

5614. I cannot account for the apparent discrepancy between the cost of working the Great Western and the Grand Junction, as stated by Mr. Gooch; for I know that the cost of working the Great Western is not less than the cost of working the Manchester and Leeds, or the Manchester and Bolton, or the Bolton and Preston, or the Lancaster and Preston, as on all those lines there is a less cost; therefore it cannot be inferred, as between the Great Western and those lines, that there is any superiority of Gauge.

Economy of construction and working.

5616. When you say that you know that the cost of the Great Western is not less, what is the ground of your knowledge?

I understand it to be about 10*d.* per mile on the Great Western. The cost of working the locomotive power on the Manchester and Bolton and the Manchester and Leeds has been about 6¾*d.* I have been reminded by Mr Bidder (I had forgotten the circumstance) that last year we had a tender from Mr. Fairbairn, to work a series of lines in the West Riding of Yorkshire with very steep gradients,—gradients averaging almost 1 in 100, at 10*d.* per mile.

5617. As regards the construction of the Great Western, do you believe it to hold out any advantages over the Narrow Gauge construction?

If you mean with respect to the longitudinal bearings, no. There is no connection between the Gauge and longitudinal bearings. There are advantages in both kinds of way. I laid down longitudinal bearings on the Manchester and Bolton, a Narrow Gauge line. I am now laying down railways with transverse sleepers, and the rail and chain.

Break of Gauge.

5628. There can be no doubt about the Break of Gauge being a great evil. The fact is, that the interchange of traffic at a station where there are many lines, as at the Normanton station, is a difficult matter: the sorting of the trains there alone occupies a very considerable time; and if you have not only the sorting to do, but the changing to do, I think it will be attended with considerable inconvenience. I know last Session we obtained a Bill in Parliament for the Wakefield, Pontefract, and Goole Railway, which avoided the Normanton station, starting

from Wakefield; and the reason alleged for that arrangement, and which had very great weight with the Committee, and, I think, induced them in a great measure to pass that Bill, was the obstruction which would arise to the traffic from having to pass through the Normanton station, simply because at the Normanton station several lines meet, and the sorting of waggons alone occupies a great deal of time: every traveller finds that. In the first place, it would require that you should have a set of men constantly waiting to carry on this operation, and do nothing else; because otherwise it would be found that the men when wanted were engaged in something else just as necessary, and if they were to leave that and come and look after those waggons, they would be obstructing some other process which was going on at the station; so that you would have to keep men constantly in attendance to do this changing of the trucks, and even with that it would be quite impossible to do it in the time. It is not simply the lifting of the body from one waggon to the other; it is getting the waggon to its place. I have known stations blocked up for hours together; it frequently happens that the sidings are blocked up with a dozen waggons together. You cannot get one waggon where you want it to be, because there are large trains in the way, which you cannot move.

The Break of Gauge a great evil.

Break of Gauge would require a set of men for that transfer alone.

5630. Supposing a line to be made from Oxford to Rugby, the greatest public convenience would be obtained by having the break of Gauge at the point where there is the least changing to do—decidedly where there is the smallest traffic.

5631. We are told that at Rugby, being a point of convergence of several lines, detention must always take place there, to marshal the trains in the journey for Oxford, and that the time required for the marshalling of the trains, would also admit of changing from Gauge to Gauge by

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some mechanical process; do you imagine that that would be the case?

Mechanical changes of loose bodies not to be done in the ordinary time for changing a train.

There is no doubt you can do almost anything by mechanism, and you can change a waggon body from one set of wheels to another with ease; but that you can do it in the ordinary time of stopping a train, is quite out of the question. I have had some experience of it. The Manchester and Bolton Railway Company carry goods in loose boxes. Bleachers, who take cloths from Manchester to bleach at Bolton, and bring them back again, were induced to go upon the railway by boxes being provided for them: they put their goods at the warehouse upon a truck; they then take them to the railway station, and they are taken upon the line to Bolton; they are then taken at Bolton upon a truck to their works, and bleached and brought back in the same way. That has succeeded tolerably well; but then it is in this way, the bleachers have an establishment at each end, and clerks and trucks, and their own persons attend at the station, and see the goods lifted off, and see them put into the truck, and taken into the town. Still that occupies a very great time; it is merely a means of overcoming the difficulty of changing—not from a Broad Gauge to the Narrow Gauge—but from a railway to a turnpike road; it is a thing which we do as an act of necessity, but would be very glad to get rid of it.

Bleachers have separate establishment to manage loose-box system.

5632. The loose boxes were, in the first instance, the railway company's; they found them on starting it, but since then the bleachers have found their own.

5634. There is inconvenience enough about it to make a railway, with very low tolls, little better than the turnpike road. Some of the bleachers avail themselves of it, and some do not.

Loose coal boxes not in increasing use.

5640. Coals were carried in loose boxes, to some extent, on the Manchester and Liverpool Railway at first, and I am not aware that it has gone into disuse,

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but there does not seem to have been an increase in that mode of carrying on the work; the coal trade is now carried on in waggons of the usual form.

5642. I think no mechanical contrivance would give the facility that would be necessary for the purpose of trans-shipment, without causing great inconvenience to the commerce of the country; nothing is easier than to lift a waggon and put it anywhere you please; it is the simplest thing possible; we have been lifting stage waggons these four or five years, but still it is the room it would take, and the delay it would occasion, which, of course, with a very large train, is very serious. And then again, in a manufacturing district like Lancashire and Yorkshire, there are a great number of branches and a great number of stations; you can afford to keep a man at each station to keep the switches clear and so on, but if you carry on this changing, you must have a large establishment at each place, which no railway company can afford.

The room required the delay occasioned by lifting waggons would be serious.

5643. Could you, upon the Manchester and Leeds line, place the Broad Gauge without inconvenience?

No, I think not; it would be exceedingly dangerous; that is, if you made the waggons wider it would increase the danger very much; guards and others moving backwards and forwards amongst the carriages would be knocked off constantly: we have had a practical proof of that upon the Manchester and Bolton Railway; some of the bridges there are constructed with pillars, and the space is 18 inches to 2 feet, and we find it very troublesome indeed; constant watchfulness is required: we have had two or three accidents at one bridge, and have been obliged to remove the bridge. Nothing is more dangerous than to be pinched for room between the sides of loaded waggons or carriages. I do not think any system contemplating that would be advisable.

Mr. Joseph Locke.

Mr. JOSEPH LOCKE, Civil Engineer, Engineer of several English and Foreign lines; completed the Grand Junction Railway.

(In conjunction with Mr. R. Stephenson, answered Report made by two celebrated Engineers against employing locomotive power on the Liverpool and Manchester Railway.)

History of Gauge.

259. What is the Gauge of the Grand Junction Railway?

Four feet 8½ inches.

The Gauge of the Grand Junction and the Lancaster and Preston Railways 4 feet 8½ inches proposed, in order to have uniformity with the established Gauge.

260. Can you state under what circumstances that Gauge was selected?

So far as the Grand Junction Railway is concerned, there is no doubt that it was selected because it was surrounded by other railways of the same Gauge. I thought it important to have uniformity of Gauge in that district.

267. What is the Gauge of the Lancaster and Preston Railway?

The same as the Grand Junction, 4 feet 8½ inches.

268. Did you propose that Gauge?

I did.

269. What were the circumstances that induced you to propose it?

The circumstance which I may say has induced me in all other cases, viz., being in connection with railways of what I call the established Gauge.

272. I think when the question was agitated with reference to the Great Western Gauge, the South Western was too far advanced to admit of any change of Gauge, for when the South Western bill passed it was not known that the Great Western would have changed the Gauge at all. I mention that, because I was

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engaged to give evidence in favour of the Great Western Bill at the time that discussion went on between the South Western and Great Western Company, and I never knew that it was contemplated to have any different Gauge than the established Gauge of the day, till the year after the Great Western bill passed; certainly it was never, to my knowledge, mentioned in any discussion on the bill during the passage of the bill.

Mercantile evil from diversity of Gauge between Great Western and South Western.

279. Do you apprehend that any mercantile evil will result to the traffic of the country by the difference of Gauge between the Great Western and the South Western Companies?

Most unquestionably.

311. I am Chief Engineer of the Paris and Rouen, and Rouen and Havre Railways. At Paris we form a junction with the St. Germains Railway, which is on the 4 feet 8½ inches Gauge.

346. You were then compelled to adopt that Gauge as you joined a line which was previously constructed?

It was previously constructed, but we were not compelled to adopt that railway; we might have taken a separate entrance into Paris if we had wished to do so.

347. What is the length of the St. Germains Railway?

Ten or twelve miles.

348. What is the length of the Paris and Rouen?

Eighty miles.

349. In the event of desiring to change the Gauge on the Paris and Rouen, did you feel competent to change the Gauge on the St. Germains?

No; if we had thought it desirable to make a new Gauge, we should have adopted a new entrance into

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Paris, and not have touched the Gauge of the St. Germains line at all.

350. Did the question of Gauge much occupy your attention at the period of the passing the Paris and Rouen line?

Question of Gauge did not occupy attention, having got rid of original difficulties.

It did not, for this reason; the difficulties I alluded to before, viz., the complexity of the machinery under the boiler had been got rid of; the outside cylinders which were applied on the Grand Junction first had been completed, and had perfectly succeeded, so that in the Paris and Rouen line I had not the difficulty of the old engines, and I adopted the same description of engines on the Paris and Rouen that had succeeded on the Grand Junction, namely, engines with outside cylinder without any machinery under the boiler, except the eccentrics.

351. So that in point of fact you did not think it necessary to increase the Gauge from 4 feet 8½ inches to 5 feet and upwards?

I did not.

379. Was the Gauge fixed for the Ayr Railway before you formed the Glasgow and Greenock Railway?

It was not, the two bills passed in the same Session of Parliament, and they agreed to adopt the same line to be made at the joint expense of the two parties between Paisley and Glasgow; the Gauge there was quite an open question.

380. After consideration, was it at your advice that the 4 feet 8½ Gauge was adopted?

Lays stress on the commercial advantages of the Narrow Gauge.

Yes; but I think it is fair to say, that the consideration with me always has been the necessity of a uniformity of Gauge, looking at it as a commercial question. I have never varied in my opinion of the advisability of keeping the Gauge uniform; I may say that I have done that all through the west of England and in Scotland, and having fixed that Gauge at Paisley,

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and at Lancaster, the Caledonian and the Scottish Central, and all the other lines will be made on the Narrow Gauge, on account of the commercial advantage that they should be so laid down.

385. The Manchester and Sheffield line is 4 feet 8½ Gauge also?

It is.

Never felt want of space since engines improved.

386. For the same reason, I presume, as the others?

No doubt. I may state that I, for myself, have never found, except in the first instance, when our engines were complex, any want of space for the proper working of the engines in the present Gauge. Having got rid of that difficulty, I have never seen any necessity for increasing the Gauge.

Break of Gauge.

295. Have you at all considered the nature of the inconvenience that would result from the two Gauges coming into contact for the through traffic?

Yes, I have considered the inconvenience of it; it must certainly involve the inconvenience of a change of carriages on the part of the passengers, and probably on the part of the luggage, too, and the merchandize. A change whether in mass or in detail I am not prepared to say; but it would involve a change both of one and the other, and that cannot be looked upon but as a serious inconvenience.

296. Do not you imagine that it would be possible to lay down other Narrow Gauge rails on a Broad Gauge railroad, so as to carry the Narrow Gauge traffic continuously?

Yes, quite possible; but then that is a very great expense, and it would be attended also, particularly

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with reference to the stations, with some inconvenience.

297. Taking the Salisbury station, for instance, would it require that station to be very much enlarged if the two Gauges met there?

Wherever two Gauges meet the station must be larger, and of a peculiar construction.

There is no doubt about it. Wherever the two Gauges meet, the station would want to be not only larger, but of a different construction from what it would necessarily be if it were made for either one Gauge or the other.

298. Do you imagine that the mixture of the Gauges would tend to diminish the public safety?

There is no doubt about it.

299. By a mixture of the Gauges, you mean the two Gauges upon the same line?

Yes.

300. But that you would scarcely recommend?

From necessity we adopt what we cannot recommend.

I would not recommend it. If it were a matter of necessity I might adopt it; we adopt many things which we should not recommend, from mere matter of necessity; and if it were imperative upon us to take for a short distance Narrow Gauge lines upon a Wide Gauge railway, we should find some means, either by going more slowly, or taking precautions in passing over it without absolute danger; but still I would not recommend working the line in that way.

A third rail laid down on Broad Gauge would not give the line of draft in the centre of the road; at high speed and upon curves it would be dangerous.

301. Would you recommend the introduction of two rails or one rail, using one of the Broad Gauge rails, and the other a Narrow Gauge rail?

I should say that unless you put down two rails you could not travel quickly with any safety; you would not have the line of draught in the centre of the road, which in my opinion with high speeds would

be bad: I should not like to risk that; I should say that it would be better to put down two rails, by which they would be brought to the same centre.

302. It would be almost impossible to propel any trains with rapidity unless the line of draught were in the centre?

It would be very dangerous indeed; upon lines where there are curves I think it would be exceedingly dangerous.

395. Had you, from your own experience, a desire to change the Gauge, the Caledonian line would have given you as good an opportunity as any other, that line starting from the point which was the general focus of the northern lines?

No; I do not think the Caledonian would have given me so good an opportunity as the Greenock, because the Greenock commenced at Glasgow, and was on the side of the river where there was no existing railway; it was an open field on that side of the water. The Edinburgh and Glasgow Company considered the question of the Gauge, and came to the conclusion to adopt the Narrow Gauge, and I think they did wisely. I never hesitated about adopting the same Gauge for the Greenock, and for the same reason I did not hesitate to adopt it for the Caledonian; but if the Edinburgh and Glasgow had made their line of the Wide Gauge, it is clear that we could not have made use of that line for any part of its length. And, with regard to any line coming north and south, it could not have formed any communicating link between Edinburgh on the one hand and Glasgow on the other, and that would have been a serious inconvenience.

399. If you were engaged as engineer for a company, independent of the Birmingham or Great Western, to unite Oxford with Rugby, what Gauge

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do you suppose you would select for that particular line?

If engineer for a new company in England would select Narrow for sake of uniformity.

I should most unquestionably select the Narrow Gauge, and I would do it upon this principle; that as there are far more Narrow Gauge railways made than Broad, I think you ought to limit the inconvenience which must necessarily be felt from the change within the smallest possible compass; and if the result of this contest and this trial shall be that you must have two Gauges in order to get rid of the annoyance of changing, it is far better for the public and for the companies that it shall be done as between Oxford and London than as between Rugby and London. It is for that reason I would not even allow a chance of the double line being put upon a greater space than is now rendered necessary by the Broad Gauge lines that are constructed; and I would apply that opinion not only to the line from Oxford to Rugby, but from Oxford to Worcester and Wolverhampton,—to the whole of the lateral lines; in fact, every line that has passed Parliament during the present session.

400. In fact, you think that a diversity of Gauge is an evil, and that it should be kept within the narrowest limits?

I do; and believing, as I do, that wherever the change of Gauge is, it will necessitate hereafter either an entirely new line to get rid of the evil, or the making a Narrow Gauge line upon the broad; believing that that will be the event, it is, I think, better that you should now continue the Narrow Gauge, and have the Double Gauge upon the shortest possible length.

401. Suppose you introduce upon the Broad Gauge lines Narrow Gauge rails, you only get rid of one-half of the evil, that is transferring the Narrow Gauge traffic upon the Broad Gauge line, but the

converse of that you do not obtain without a change of Gauge, because trains coming up to Oxford and having to pass to the north must change at Oxford to the Narrow Gauge carriages? Mr. Joseph Locke.

Unless it was a Narrow Gauge carriage that had come all the way from London, which might not be the case certainly, there is an inconvenience in that; but the Broad Gauge carriages belonging to the Great Western need not go beyond Oxford; it is only the trains that are going off from the line that would carry that traffic, and they would be the Narrow Gauge carriages. I do not think it is necessary that the Broad Gauge carriages should go upon the Narrow Gauge lines—that would be so if we had a lesser number of miles of railway upon the Narrow than the Broad Gauge, but what you have to do is to limit upon the smallest number of miles possible the inconvenience of a double Gauge. Best to limit evil of diversity, and number of Broad Gauge lines.

402. Are you of opinion that the Break of Gauge should take place where there is much or where there is little traffic?

I am sure I can scarcely answer that question: where there is little traffic would appear to me to be much better.

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405. Which will be attended with greater expense to the Great Western Company, the altering of their Gauge from 7 feet to 4 feet 8½ inches, or the introduction of Narrow Gauge rails within their broad rails, taking into consideration the change of stock and engines? Remedies.

The first expense would be the least, and I think if the Great Western Gauge were changed to 4 feet

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8½ inches; in fact, if every one of the Broad Gauge railways that is now laid down were changed to 4 feet 8½ inches, the evil which you are sitting here to consider would be in the best and in the cheapest way got rid of. I think the best way is to allow the Great Western line the fullest extent of the lines at present made, but the extension of the Great Western to Rugby on the one hand, and towards Salisbury and Plymouth on the other, should be made upon the Narrow Gauge, and if there be little inconvenience in the change of Gauge, at all events that would be limited to the Great Western main line, of which that Company would have the perfect control. And my opinion is, that they would find hereafter that the inconvenience of that transfer was so great, that it was worth their while to lay down the Narrow Gauge from Oxford to London, in order to get rid of the change, and in that case they might do it without great expense and without any very serious loss.

368. Have you at all considered the subject with reference to a change of Gauge that will take place should the projects be carried out between the South Western and the Great Western?

Loose bodies not safe, not economical, and weaken carriage.

I think as a mere matter of contrivance for changing traffic from one Gauge to another there is no difficulty about that; it is very simple. The difficulty practically is in the use of carriages that are carrying loose box bodies, supposing you are to have bodies transferred to a truck, it is not so safe, and certainly not so economical. I recollect in the early part of the working of the Liverpool and Manchester line loose coal-boxes, which had to be taken into the town, and it was found to be, and I dare say it was, a very good machine for lifting them on and off; it saved great labour, and as a mere matter of calculation there was great apparent economy in it, but the boxes got so broken, so much kicked about, being loose, that I believe they are all given up, and I think the detaching the body from the frame itself is a very bad thing

in reference to the strength of a carriage of any kind, for the sides of the carriage when fastened to the frame give great strength to the frame itself for the purpose of resisting shocks of any kind. Mr. Joseph Locke.

369. Do you think the public safety would be at all endangered by having the passenger bodies removed from the under frames? Safety.

I certainly do think so; I think in many cases of collision the body being attached to the frame gives greater security to the passengers. I may say this because the strength of the carriages affords great security to passengers in all those collisions.

370. Have you ever seen in any of the French towns, or any of the French lines, the mode of shifting the diligence?

Yes, we do that; the diligences are put on loose wheels, placed under the frame, and with a little hoist lifted up on the body of the carriage, and put upon the truck of the railway, just in the same way as a gentleman's carriage, and taken off in the same manner, and dropped on to a frame of four wheels at the end of the journey. The contrivance is very simple and very facile, but not very safe. They take that truck as it stands when the diligence is loaded; there is first of all a truck made for the diligence. It is not a truck with a simple bottom to it, but has sides to it, and it is then like an ordinary truck; and I believe that when the diligence is upon the truck, it is certainly not so strong as if it were part of the same carriage, but it is very heavy, and they carry a weight upon the Paris and Rouen line of eight or nine tons when the diligence is loaded; and if it were not for the change, you might have a weight of only about five or six tons, so that in every carriage you are carrying a great deal of dead weight in order to avoid the necessity of changing the carriages. There was a collision on the Orleans Railway by some sudden stop- French diligences are transferred from railway to loose wheels.

On a collision on the Orleans railway by a sudden stoppage one of the diligences throwu off.

Mr. Joseph Locke.

page; one of those very diligences was thrown off its position.

446. Do you foresee any increased difficulty in the ordinary working as regards the maintenance of way, packing the rails, &c., if you were to have combined together the Narrow and Broad Gauge?

Certainly; it could not be done well if you laid down two rails.

Cost, construction.

324. Supposing the Directors of the South Western or the Grand Junction line had determined to adopt the Broad instead of the Narrow Gauge for those lines respectively, are you at all aware what increase or diminution of cost would have resulted in the construction?

Mr. Brunel has increased size of timbers and weight of rails beyond original calculation, while on Narrow Gauge original sizes and weights maintained.

No, I am not. At the time the discussions upon that subject took place, I recollect being satisfied that the Wide Gauge was more expensive than the Narrow one, by reason of the longer sleepers, and the greater space for the embankments, and cuttings, and so forth; but I perfectly well recollect that Mr. Brunel always maintained the reverse, therefore, it is quite fair that his opinion should be taken as against those of the contrary opinion; but at that time Mr. Brunel calculated upon very much smaller timbers than he is now using, and a very much lighter rail than he is now using, and whilst the Narrow Gauge lines have maintained the same size of the sleepers, blocks, and rails, which they then used, I think Mr. Brunel would himself admit, that he has been obliged to go to far more cost in the construction of the road than he calculated when he made his estimate.

327. With respect to the increase of expense required by the Broad Gauge, if you go into the question of bridges and tunnels, the width of cuttings and embankments, you will find that a very great increase

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will take place; you will find on the Great Western Railway the outside rail is nearer the slope than on other lines.

338. You are of opinion that it is easier to keep in repair a railway with transverse sleepers than with longitudinal sleepers?

Unquestionably, and not only easier, but you can keep it in better repair with the same labour than a longitudinal road.

339. Does it appear that the Great Western have a larger cost of maintenance than you have upon your lines where the transverse sleeper is used?

I have no means of knowing that; you will get that probably from Mr. Brunel. Up to this time great changes have been made in the Great Western road by substitution; they are at this moment taking up the Great Western road, and laying it with heavier material; what part of that is due to the original lightness of construction, and what is due to the difficulty of keeping the road in good repair, under the circumstances I do not wish to offer an opinion upon, but I am sure that the principle of construction is not so good as with transverse sleepers.

445. I know that on the South Western we burn much less coke per mile than they do upon the Great Western.

Safety.

328. Are you of opinion that any danger to the public safety is the result of the rail being near to the edge of the embankment?

Danger of narrow embankment in case of running off rails. Prefers broad embankment.

No; if the embankment is steady, and the engine keeps the line, it makes no difference; but if the engines were to come off, and the embankment is very narrow, it is evident there is a much greater liability of its falling over. For my own part, I always prefer a

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wide embankment; and where I have an opportunity of widening it, by taking away the material from the slopes in the cuttings, I always prefer to go even to additional expense to put it alongside the embankment, to widen it to even 18 feet beyond the original limits; I think it gives greater security in the event of the engine getting off the line.

329. What is your ordinary dimension?

Thirty feet.

330. That will give you how much between the edge and the outer rail?

Seven feet on each side.

331. So that, in point of fact, if the engine were to get off the rails, it would in all probability remain upon the embankment?

Yes, I think it would, unless it were to get off both rails.

333. Is there a greater probability of the Great Western engines getting over the embankment by getting off the rail?

I do not know, having seven feet Gauge, how far they would be more likely to get over the side of the embankment; but it appears to me, that in order to prevent an accident of that kind, and to take advantage of the outer rail acting as a guard to the inner wheels of a train which had left the line, the embankment should be so wide as to prevent the off wheel from getting on to the slope, and throwing the engine over before the guard rail came into operation.

334. You would have, therefore, the same breadth of embankment beyond the rails that you have breadth of Gauge?

Yes.

335. So that you would require 7 feet with the 7 feet Gauge? Mr. Joseph Locke.

Yes; if you are to take advantage of the rail as a guard.

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407. Suppose the whole of the railways in this district of England belonged to the Government, and it was intended to make extensions on the system spoken of, should you be disposed to recommend, as a Government officer, the Great Western Gauge to be changed at once to the Narrow Gauge, as being likely eventually to lead to the greatest economy and the greatest commercial advantage? Opinions on Gauge.

I am not prepared to say that I would recommend that change in the first instance; for this reason, the Great Western Company, through its officers, have declared that the inconvenience arising from the change of Gauge is very little. Then I would say, you shall have an opportunity of testing that. All the railways that are now projected, but are not made, we will not involve in the extra expense. All the railways that are now projected from Corsham, called the Wilts and Somerset, shall be made upon the Narrow Gauge, and the transfer shall take place upon the Great Western line, proper; and if found hereafter, which I believe will be found, that there is more inconvenience and more annoyance with that change of Gauge than they anticipate, they then will come to advocate that which you now suggest to me. But, in the one case, to compel the Great Western Company to change their Gauge would be a hardship, without compensation; in the other case, it would be no hardship at all; if they do not choose to make the railways, for which they obtained Acts of Parliament last year, upon the Narrow Gauge, other parties will; the inconvenience would then be limited, without any

To compel the Great Western to change their Gauge without compensation would be a hardship.

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further expense, and it would give the Great Western Company an opportunity of proving what they themselves assert, that there is no inconvenience in making the change.

408. My question was, assuming that the whole of the railways in this district belonged to the public, and that the public had a right to deal with them as they thought proper, should you be disposed to recommend a change at once?

I would recommend the change, because I believe there will be the inconvenience, which I apprehend would be serious; but, seeing that there are those parties who entertain a different opinion, I think it is but fair to those parties that they should have an opportunity of trying what they can do, because it is only deferring the change, it is not augmenting the evil. I wish to be most distinctly understood; my opinion is this, that the Great Western Company would have reason to complain if I suggested anything in this case, as a South Western Company's officer, against its interest. I do not wish to do it; but those lines which they are going to make ought to be made subservient to the public interest.

303. From your present experience of the Broad and Narrow Gauge, suppose you had a fresh district of country in which to project a series or system of railways, should you be disposed to take the one or the other?

I am not quite sure that I should adopt either the one or the other. I think if we had to begin afresh, I might adopt another Gauge rather wider than the Narrow Gauge; but certainly I would not take a Gauge so wide as the Wide Gauge.

306. We have now wheels on the Narrow Gauge 6 feet 6 inches in diameter, and we have some engines on the South Western where the boilers certainly are

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Construction of Engines.

not higher than the boilers of some of the engines which we have been running with wheels of 5 feet 6 inches; and the reason why they are kept so low is, that we have done away with the cranked axle upon those engines. We have placed the cylinder outside the boiler, and we have brought the boiler very nearly on to the axle, and we have thus saved as much by avoiding the crank as we have lost by increasing the size of the wheel, keeping the centre of gravity very nearly where it was.

415. Are you aware of the motive of the engineer of the Great Western Railway for adopting the Wide Gauge after the bill had passed through Parliament, or the reasons assigned?

Broad Gauge selected in order to have higher speeds, a better road, economy of constitution.

The reasons assigned were given in his own statement when the inquiry was instituted by the proprietors of that line, and I certainly thought that his intention was to have higher speeds; that was the first thing; a better road, and economy of construction; because I think I have seen some of Mr. Brunel's earlier estimates, showing it to be cheaper than the Narrow Gauge, at all events not dearer. His great object must have been greater speed and greater economy. I believe at that time the notion was entertained that one great item of expense in locomotive engines was attributable to the rapid reciprocation of the piston. He thought, in common with many engineers, that to diminish that was a great advantage, and to some extent there is no doubt whatever about the truth of it; but locomotives, on the Narrow Gauge, have diminished in the expense of working from 2*s.* 6*d.* to 2*s.*, and down to 1*s.* 4*d.*, and now they are at 10*d.* per mile run; and still, with this rapid reciprocation, we do not find that, even with the large wheels of the Great Western, its expenses are any lower; they may be a little; but there is no doubt of this, that Mr. Brunel's earlier intention was to have wheels of a much larger diameter than he now uses; he did use wheels 10 feet diameter. I believe the largest ordinary engine-wheels which

Did use once 10 feet wheels, now 7 feet.

Mr. Joseph Locke.

they use now are about 7 feet; that is only 6 inches larger than we are using upon the South Western at this moment. I do not know of any other objects than speed and economy. I believe great advantage was to be gained by saving in the working expenses, and I confess I, for one, have seen no evidence of saving on the Great Western line. I should be glad to be shown it, but I have seen no account showing their working expenses to be less than those upon the Narrow Gauge lines.

Sees no evidence of saving on the Great Western line.

394. Are you of opinion that the locomotive power is obtained at a less cost upon the Narrow Gauge than upon the Broad Gauge with the same speed and power?

Comparative cost of working.

I cannot tell. Mr. Gooch knows better the cost of the Great Western, and he knows very well the cost of the South Western, for we have a friendly interchange of accounts of expenses, and I am not aware that it is any dearer on our line than it is upon the Great Western; I rather think it is a little cheaper. I do not think it varies very much. But I am not sure that the Great Western have quite done supplying themselves with new stock, and till that is done we cannot exactly get a fair balance or comparison.

Extension to Broad Gauge.

417. Supposing it should be found desirable to change the Gauge of the South Western to the Broad Gauge, what interruption would that be likely to cause to the traffic upon that line during the change?

There would be great inconvenience in it; the better plan, I think, would be to take a certain length, and use a single line. In any substantial repair, such as entirely taking up the rails or sleepers, or putting in blocks instead of sleepers, I have always thought that the simplest mode would be for a mile, or a mile and a half, to take up the rails, and use a single line, keeping a policeman at each end.

Mr. Joseph Locke.

418. But you would have to alter the tunnels?

Yes, our tunnels would not be large enough for the Wide Gauge.

419. Nor your bridges and viaducts?

Some would not, and some part might be altered. It is not an impossibility, but it would be attended with considerable expense, and great inconvenience, if it were to be done during the time the passenger traffic was carried on; but if you had to change the tunnels, you could not carry on the traffic. My other answer was with reference only to the alteration of the permanent way.

Mechanical convenience and passenger comfort.

303. The Wide Gauge is not necessary for the machinery, in my opinion, and as to the public convenience in the construction of large carriages, which seems to me to have run away with the public in some measure, larger carriages, if they are necessary, can be had upon the Narrow Gauge as well as upon the Wide, particularly in reference to height. It appears to me that it does not add to the convenience of the public to have four or five sitting abreast. If you give as much room to each passenger as they give upon the Wide Gauge, which I think we do, the Narrow Gauge carriage, carrying three on a side, are quite as comfortable as the Broad Gauge, carrying four.

Space for each passenger as great on Narrow Gauge as on Broad.

304. And you see no difficulty in giving the same height to the carriages?

Not the slightest.

305. There is the same height now in some of the carriages, is there not?

I believe 6 or 8 inches have been added to the height of most of the carriages upon the Narrow Gauge lines in the last two years.

390. As regards the shape of the carriage, its width, with reference to its length, do you apprehend

Mr. Joseph Locke.

that that makes any difference as to the ease in riding, with regard either to the horse-boxes, or carriages for passengers? Is there less yawing motion in the one than the other?

That depends upon other circumstances. I do not see that it would affect the carriage. I certainly have, upon particular carriages in the Great Western, been more seriously rocked than I was upon a Narrow Gauge line. It was in the last carriage; where we know that there is more motion than in a carriage that is braced up, and confined in the middle of the train; but I do not think that the relative width of the carriage would necessarily affect the rocking motion.

465. You have spoken of the accommodation of the first-class passengers on the Great Western carriages, where there is space for eight. You do not think they afford more accommodation than the six inside carriages; do you think the accommodation for the second and third-class passengers is equally good on the Great Western as on other lines?

Second class carriages on Great Western inconvenient.

I do not; because I think when people are sitting on a long bench across a wide carriage, not being near the window so as to see anything, they are not comfortable; they cannot put their heads out to look at the country; and I think that increasing the number of people on one bench is sometimes an annoyance, and is not pleasant to the passengers themselves. My notion is, that if every person could have a corner seat he would prefer it. Then the Great Western Company, in order to make corner seats in their wide carriages, have put a partition in the middle. A man in the middle cannot see out, and he sits there all day, and cannot see the country at all. If I were going by a train, I should get a corner seat, where I could look out of the window.

Mr. Joseph Locke.

466. For the same reason you would not get in the middle?

I would not. You will find that all persons get in the corners near the window; those are the four first places taken. It shows what the public wish to have.

Mineral convenience.

439. Are you sufficiently acquainted with the mineral district to be aware whether the Wide or the Narrow Gauge would be most suitable to the coal-owners or the mineral proprietors?

In the north of England very small waggons used for coal, more convenient for horse to move and to run up to pits on side lines.

I can scarcely answer that question. I know the mineral districts very well, and in those districts where the largest quantity of coal is carried, they carry them on very small waggons; for instance, the Newcastle chaldron,—why they adhere to the Newcastle chaldron I cannot tell. I know that on the Paris and Rouen we carry five tons net weight.

440. They have small waggons on the North Midland?

Yes; and in most of the new railways they have made waggons that will contain five tons; but in the North of England, where they carry 50 times the amount that they do in the South, they still adhere to the small waggons; there is an advantage in it; the axletrees need not be so strong, and a horse may move it easily about; there is a facility of motion which there is not with the heavy carriages.

441. What weight of coal will the Great Western carry in their coal waggons?

I do not know what they carry, but you may make a waggon upon either line to carry 10 tons of coal, if it be any accommodation to the mineral districts; but I do not think there is any advantage in one system over the other as regards the size of the waggon; if a large waggon is what you want, you could get it on either one Gauge or the other.

Mr. Joseph Locke.

442. With reference to the side lines running up to the pits, should you say that the Broad or the Narrow Gauge is more convenient?

I should say that the Narrow Gauge is more convenient, and probably for this reason; they have small waggons for the convenience of running up to the pits in order to load them.

Safety.

If allowed to choose would neither increase Gauge nor wheels, nor speed, until roads improved. Inequalities from change of temperature.

306. I think we have obtained (looking to the construction of the road) a speed high enough, and if it were left to myself, I would neither increase my Gauge, nor my wheel, nor my speed, till I had more experience, not only in the construction but also in the strength of the materials. You can never get over the inequalities of road arising from the change of temperature and weather. You may have the most perfect road that has been standing for months and been run upon daily, and you shall have a shower of rain or a continuation of wet weather during the time the trains are running, and in two days the road may become positively dangerous, and no ordinary precautions can meet that, and for that reason I say that, till we can ensure our roads being in better order than we can now ensure their being, we ought not to go even at the speeds we are travel ling at.

Speed.

315. In point of fact, can you now attain as high a velocity for the express trains on the Grand Junction as is obtained upon the Great Western?

Could have 50 miles an hour on South Western.

In answering that question I may say that I do not exactly know what velocity could be attained upon the Great Western, not having experience as to that line; but I have no doubt that we could, if it were safe, run our express trains upon either line at 50 miles an hour; they now travel 40. Our time to Southampton is two hours, and it is 78 miles, very nearly 40 miles an hour, including stoppages; and I am quite sure that, if it were a matter of necessity, we could travel at 50 miles an hour.

316. Do you think the state of the road would admit of your travelling at that speed with safety? Mr. Joseph Locke.

I do not; I am very much opposed to it; I do not think it is safe either on our own line or any other that I have ever been on.

318. Have you considered the practicability of working round curves, such as are used upon the Narrow Gauge lines with a Broad Gauge line? Curves.

Yes; I think that the introduction of the Broad Gauge would be much more difficult, in countries where curves are necessary, than the Narrow Gauge lines. Broad Gauge difficult to work in country of curves.

319. Will you favour us with any reason for your opinion?

Because with the Wide Gauge railway there is a greater difference between the length of the outer rail and of the inner rail than there is upon the Narrow Gauge; supposing the wheels are upon the same axle, they have more to make up than they would have upon the Narrow Gauge line. And it would appear, if you were to increase it very greatly, that you would be scarcely able to have curves such as are now commonly used. On the Narrow Gauge lines you diminish the difference between the two rails, and by that means you enable the wheels to pass round the curve with greater facility.

320. So that, in point of fact, the facility of turning curves is almost in the inverse ratio of the width of the Gauge?

No doubt.

391. It is generally admitted that, on the Great Western, a greater speed is obtained with the ordinary trains than on other lines?

I think that is so; but I think that that may be

Mr. Joseph Locke.

accounted for in some measure by this circumstance; the trains stop less frequently than upon some other lines. The fast trains on the South Western, I think, are as fast as they are upon the Great Western, within a mile an hour, or something of that kind; but we stop twice, and have to divide the train at the Gosport junction on the line, where we divide the passengers to Gosport and Southampton, and we travel 40 miles an hour.

392. As far as my experience goes, I have found the speed between station and station greater upon the Great Western than upon any other line; does your experience lead you to the same conclusion?

Gradients of the Great Western very superior.

I think it is very likely; but you must bear in mind that they have much better gradients on the Great Western; therefore, in speaking of the speed of the Great Western, you ought to attribute the difference in some measure to the gradients.

393. And not to the size of the engines?

Probably in some measure it may be attributed to that. I have travelled upon an engine with a 6 feet 6 inches wheel, the largest wheel that we have upon the Narrow Gauge, and it will go at a speed of 48 to 50 miles an hour with the greatest ease. I am quite satisfied that that engine would take any moderate train, consisting of six or eight carriages, at 50 or 60 miles an hour if it were desirable. An engine on the Grand Junction the other day, one of their new engines—I was not on it myself—but the party who was on it told me went 57 miles an hour; and that is only an engine of 6 feet wheel with the expansive gear motion.

416. With regard to the question of speed, you have already stated that you think as high a velocity can be obtained upon the Narrow Gauge lines with your engines as is compatible with safety?

Yes, and a far higher speed.

Mr. Joseph Locke.

427. Is it a matter of frequent occurrence getting off the line?

No, it is not; till very recently it has been of very rare occurrence.

428. To what do you attribute its being more frequent lately, with our increased experience?

Attributes accidents at high speeds to change in road produced by weather.

I do not mean that it has been only lately that we have had any accidents, but the accidents that have arisen of that kind, in the last few weeks, I attribute in a great measure to the increased speed they were travelling at. I will not say that you may not, with a very perfect road indeed, travel at the speeds you do now, and even at higher speeds; but I attribute such accidents to the change in the state of the road, produced by weather and sometimes by neglect. I know a case on the South Western Railway, when they first opened it throughout. The road being new, it was perhaps not in the most perfect state (it never is when it is new); the engine got off the line, travelling, I am afraid, somewhat faster than it ought to have done, though the engine-man was exceedingly careful. The engine-man and the fireman were killed, the engine was broken in a great many places, but the wheels and the axles were found to be all right. Nobody could tell what was the cause of the accident. I went back to the spot where it had got off. I traced the flange running on the rail; there was nothing wrong in the Gauge; there was nothing wrong in any part, except that it was a little undulating, and evidently not in good repair, but it was not apparent to the eye; and it was only by pressing a weight upon it, and seeing whether the sleepers yielded, that you could discover that the rail had subsided. That engine was placed upon the railway and taken to Southampton, without any alteration in the wheels or the axle; therefore it could not be accounted for, except that the engine must have got off by jumping, owing to the elasticity of the road.

Accidents from elasticity of rails with six-wheeled engines.

429. Was that a four or six-wheeled engine?

Six. It is the only instance that I know of a six-

Mr. Joseph Locke.

wheeled engine leaving the rails. Several accidents occurred before and since, which I did not see; but this was one that I saw, and I never could account for it except it were from the elasticity of the road.

Construction of Carriages.

458. You think that the public safety is increased by a solid frame?

No doubt about it. I believe the public safety is secured by that additional weight and strength and substance which has been given to the carriages. In stating that opinion, I know there are many engineers who think that lighter carriages may be used, and at very high velocities. Mr. Brunel and Mr. Cubitt have stated in evidence, that, by the atmospheric railway system, they will be able to keep the road in so much better order, as to be enabled to use lighter carriages, and at a higher speed than we have yet been able to use or attain on locomotive lines. My belief is, that, if you attempt a higher speed, and a lighter carriage, you will have many accidents, which is proved in my opinion by the trains leaving the rails the other day on the Great Western line. It seems that the last carriage of one of their express trains, running very fast, jumped the rail; that was the cause of two accidents, and I believe that you will never cease to have those accidents if you attempt high speed with light carriages.

High speeds dangerous with light carriages.

459. Is it your opinion that the system of having any light carriage between the engine and the passengers' carriage, instead of adding to the public safety, tends very much to diminish it?

It depends on the speed. Any light carriage at a high speed is unsafe; and I have stated before, and will repeat here, that one of the great causes of success in the safety of railway travelling is attributable to the weight of the engine which precedes the train. If the engine were a light engine, at the speed at which it sometimes travels, it would leave the rail; but, as it is heavy, it gives security to the train behind it.

311. I may say that, in the early construction of engines, much inconvenience was felt from the want of space between the wheels and the boilers, and I must say that I believe that the first impression of want of width in the Gauge arose from the complexity of the machinery under the boiler, and the necessity for having some more space by which not only the parts could be made stronger, but that they might be got at and repaired, oiled, and cleaned, with more facility; and I believe that the slight change of Gauge on the Eastern Counties, from 4 feet 8½ inches to 5 feet, arose from that circumstance, the engineer finding, when he came to design his engines, that, if he had a little more space for the application of his crank axles and his eccentrics, he would make a better engine than by being confined to the narrow space of 4 feet 8½ inches. Now, I felt, as engineer of the Grand Junction, also the same inconvenience, but, instead of directing my attention to a change of Gauge, I directed my attention to simplifying the engine itself; and the result of that was, that instead of wanting space under the boiler, we have now no machinery there at all except the eccentrics. We now place the cylinder outside the engine. We have got rid of a very great deal of complexity in the machinery itself, and the complexity which remains is on the outside of the engine and not under the boiler. In that way we have obtained what we wanted, space for our machinery, without going to the much greater and much more extraordinary expense of increasing the Gauge.

Power and Construction of Engines.

Directed attention to simplifying engine instead of increasing Gauge.

321. Are you of opinion that the Broad Gauge gives you greater power for the conveyance of heavy trains of luggage?

Certainly; it gives you greater facility by giving you a larger space to put your power in, but I have not come to the conclusion that you cannot get as much power as you want upon the Narrow Gauge. On the contrary, I am of opinion that you may get more than

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you want. I am not favourable to the system of throwing a large force upon one engine. I have, on my own lines of trains, of 60, 70, and the other day 77 waggons in one train.

Unfavourable to heavy trains by one engine.

322. The gross weight being what?

They might be part empty and part full, but there were three engines attached to it. I would positively prohibit having such a train, for this reason, it strains the waggons; if you push them the frames are thrown out of square; if you draw them you break the chains, and it always creates delay and inconvenience on the road. I think 40 waggons is enough for any one engine to draw.

323. Then you would rather subdivide the train into two or three than run a very large train?

Thinks 220 tons enough for one engine.

I would take that with a limitation. I say 40 waggons weighing 5 tons or 6 tons each, being 220 tons, is quite enough; and I say one engine would do that with the greatest ease; and if it were possible to have a greater power, a power sufficient to drag 60 waggons, I would not have it even if I could get it. I am quite sure that the engines on the North Midland with the large boilers would drag anything, they would drag a hundred waggons; those boilers are very long, and the fire-boxes are very large, and the cylinders large; and, so far as I understand, they can generate far more steam than they consume.

Construction of Engines.

415. Locomotives on the Narrow Gauge have diminished in the expense of working from 2*s.* 6*d.* to 2*s.* and down to 1*s.* 4*d.*, and now they are at 10*d.* per mile run; and still, with this rapid reciprocation, we do not find that, even with the large wheels of the Great Western, its expenses are any lower; they may be a little, but there is no doubt of this, that Mr. Brunel's earlier intention was to have wheels of a much larger diameter than he now uses; he did use wheels 10 feet diameter. I believe the largest ordinary engine-wheels

which they use now are about 7 feet, that is only 6 inches larger than we are using upon the South Western at this moment.

425. With the inside cylinder there is a liability to break the crank?

Yes; the inside cylinder had necessarily a crank-axle, and we had so many breakages of the crank-axle on the Grand Junction line, that it was not only a source of great expense, but of danger, because the crank broke when the train was going, and threw the engine off the line; and, therefore, to avoid this, which was a matter of great consequence, we adopted the change which I have suggested.

426. Is there any corresponding liability to breakage in the outside cylinder?

Not the least; we have not had a broken axle, and I do not think we have had a breakage of any kind, since the construction of those engines.

434. Are you aware of the reason why the 10 feet driving-wheels were abandoned on the Great Western Railway?

I believe it was the great difficulty first of all of getting an engine large enough to move the trains at any ordinary speed, and then the difficulty of stopping them when they once got any speed. It was difficult to start them, and then when they were started it was difficult to stop them.

435. From the movement of the wheels?

Yes; a crank of 10 inches or 11 inches is a very short crank indeed; as applied to such a wheel, if the cylinder had been 20 inches or 24 inches, instead of 15 inches, it would have made up the difference, or something like it.

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436. How would wheels of that dimension suit with a country of severe gradients?

The very large wheel does not suit; severe gradients not safe.

They would not suit at all, nor do I think that the 10 feet wheel is at all a safe wheel. The next difficulty we shall get into by increasing the size of the wheel will be in the springing of the wheel itself on its motion, from the axle not being sufficiently rigid. In going through points or crossings with a very large wheel, it is evident that a very little force applied to the flange will spring the wheel unless it is made proportionately strong, and if you do that you will have a wide boss; the bosses are 8 or 10 inches, the spokes are 4 or 5 inches, tapering up to 3 inches at the rim; if you increase it from 6 or 7 feet to 10 feet you must increase the width of your boss, and you will have a very heavy weight and very wide boss.

Mr. J. E. M'Connell.

August 11th, 1845.

Mr. J. E. M'Connell, Superintendent of the Locomotive Department of the Birmingham and Gloucester Railway, previously engaged in Mr. Bury's Steam Engine Manufactory, Liverpool.

588. Would any increase or diminution of the staff of porters result from an uniform Gauge at Gloucester? **Uniformity of Gauge.**

A very great decrease—in fact, I may state that the necessity at present existing for keeping up a staff of porters there is entirely owing to the change of Gauge. With about thirty waggons we require twelve porters to trans-ship. Now, if the Gauge were uniform, I should imagine that we could do the goods train there with four porters, for it would only be necessary to unload and load the local goods from Gloucester either way—either to Bristol or Birmingham—all goods that require to be put on board vessels will be sent on alongside the vessels, and be unloaded at the dock:—at present those porters are kept there for the mere purpose of lifting goods out of one waggon and repacking them in another, which requires from five to six hours from the time the train arrives to get them sent off again. The superintendence of the porters would not require to be so expensive. The clerks also would be reduced—the general expenses of the establishment altogether would be much decreased, and there would be less liability to delay and damage. We may safely calculate upon having nearly one-half less turn-tables and sidings if uniformity of Gauge were established; there would be

Uniformity of Gauge would reduce staff of porters at Gloucester one-third.

Half less turn-tables and sidings.

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One set of carriage sheds. Diminution of carrying stock.

At break of Gauge, tenders half stock often idle and empty.

only one set of carriage sheds and of goods sheds, where there now have to be nearly double; there would be a diminution of carrying stock—for instance, supposing a heavy train of goods arrive from Bristol, there might not be a heavy train of goods required to go back again, consequently, at the break of Gauge where those goods were trans-shipped from the Broad to the Narrow Gauge, the broad Gauge trucks would have to remain idle till a sufficient number of goods came for them; in the same way with waggons drawn away from Gloucester to Birmingham with a large train of goods, they will again have to remain for some time until they are employed, or else be required to be sent down to those points where they were required, from Birmingham, till a quantity of goods came again in the other direction to work them back, so that it would be increasing the trouble and delay of the trucks passing when there was a preponderance of traffic in one direction more than in the other.

592. But if the same Gauge continued from Bristol to Birmingham, a number of carriages would still be found empty at Birmingham that came from Bristol, instead of remaining as they now do at Gloucester?

Yes; but it would be to only half the extent, because they have two different sorts of plant waiting in the one case, and they would have only one kind of plant waiting in the other. Of course passenger carriages would be open to the same objection.

607. Both lines being now worked by one Company, do you conceive it would promote the interests of the Company to alter the Gauge of the Bristol and Gloucester to 4 ft. 8½ in.?

Essential to profit to establish uniformity.

I think it is quite essential, they will never make the concern profitable until it is altered. The success of the two lines depends on their making the Gauge uniform. I believe in all cases the parties are afraid of their goods being mislaid or delayed, and that confidence would be restored if the Gauge was uniform.

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615. Without making a calculation of what would be the cost of altering the Broad Gauge to a Narrow Gauge line, is it not difficult to form an opinion how far it might be profitable to the Company to make the change?

I think it is a matter quite of necessity, and that the cost would form a very small fractional part of the ultimate profit to the Company resulting from it. I think the expense of the management of the two concerns, and all the inconvenience of a difference of Gauge must be balanced against the cost of altering them into one Gauge; and I think, balancing them in that way, there is no question that the advantage would be very great of altering the Gauge of the Bristol and Gloucester to the Narrow Gauge.

617. Do you imagine you could save £10,000 per annum, which, at £5000 a mile, is what the change would cost?

I have not the slightest doubt of it; but I think £5000 is a very liberal sum for the alteration, for this reason:—With respect to waggon stock, it would take, for instance, for 50 miles of railway, a certain number of waggons; but for 100 miles of railway it does not take a double number of waggons, because if the waggons work through, a small addition, comparatively speaking, would work the 100 miles beyond what is required for the 50; having the carrying stock for the Birmingham and Gloucester portion, it would require a very small addition for working the other portion of the line.

100 miles with uniformity do not require double the waggons for 50 miles.

Break of Gauge.

510. When the decision was come to for making the Bristol and Gloucester Railway on the Broad Gauge system, the expense and inconvenience of trans-shipment was not understood. After the line was opened, we

Inconvenience of diversity not understood when Broad Gauge adopted.

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found, and have continued to find, very great inconvenience in working the line both before and after the amalgamation with the Birmingham and Gloucester — It has been a subject of serious consideration how the inconvenience of passengers changing carriages could be most easily obviated. It is done now by the passengers leaving the carriage of either Gauge, and walking round the shed to the other side, where the Broad or Narrow Gauge carriages are standing. The luggage is put into little barrows which are conveyed round with them; in fact, it is almost like taking a fresh train, and delay is caused by the whole of the passengers and luggage having to be trans-shipped.

Mode of transferring passengers from one Gauge to another.

597. It is no greater inconvenience than passengers getting out at Wolverhampton to eat their luncheon, and getting in again, or the same thing at Swindon?

Inconvenience of transferring luggage and invalids to Cheltenham, &c.

There is the inconvenience of the whole of the luggage having to be removed. We have invalids often travelling, and it becomes a matter of delay to the train. Parties going to Clifton or Cheltenham. Then sometimes luggage gets mislaid and mis-sent. With our average passenger trains the delay does not exceed half an hour.

With respect to goods trains, our plan now is, when the train arrives at Gloucester, to select out those waggons that have not been properly marshalled in the train at Birmingham, which sometimes is the case, the pilot engine selects those which will require to go through to Bristol, they are put into a line parallel to the main line, and on the other side of the line is a Broad Gauge line, on which the Broad Gauge waggons are standing; they are run into a shed. The sheets are taken off the Narrow Gauge waggons, and the lighter articles are removed by hand. Of course that involves considerable time. The lighter articles are all taken from the top, those that are brittle and likely to be damaged; and as to all the heavy packages at the bottom, cranes are required to lift them out and repack them on the Broad

Mode of transshipping goods.

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Gauge waggon. The greatest care is necessary; sometimes it occupies considerable time in getting all those things packed and repacked. The waggons in the shed, again, on the Broad Gauge are marshalled in proper time and order to go by the Bristol train, and I calculate that that occupies about five hours: that time is necessary, upon the average, for the trans-shipment of the goods from one train to the other. There are certain palliatives which may be proposed, and which look very well in theory, but unfortunately when you come to test them in practice, they are found to be highly objectionable. As an example:—On the Midland Counties Railway they had at one time a project of shifting the bodies of waggons from one to another, which is one plan suggested of overcoming the break of Gauge, but it was found so very inconvenient that it was never carried out. They had wrought iron bodies prepared for coal waggons, which were to be lifted by means of a triangle and crane, and put upon railway waggons. I saw not long ago about thirty or forty tons of these bodies, which had never been in use, and which were sent to an iron forge to be broken up for scrap.

An ordinary transfer occupies five hours.

Palliatives impracticable in practice.

Midlands tried and abandoned loose bodies to waggons.

Forty tons of new iron bodies broken up for scrap.

624. Do you imagine that that system was sufficiently tested before it was given up?

I am quite certain that it was. On the Grand Junction they have tried it at Warrington, I believe, and on several other railways. I know it has been tried, and in each case it has been abandoned.

Tried on Grand Junction and other Railways, and failed.

626. Are you aware whether it was a defect in the system, or want of perseverance in the individuals who were employed to carry it out?

I only judge from the result of the trial. I have no doubt that, after having expended the sum of money which they must have expended in procuring those wrought-iron bodies, they would not give it up without having given it a sufficient trial to test its merits.

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637. How would you carry into effect the operation of laying down the Narrow Gauge line within the Broad?

Thinks new railways better than narrow inside broad.

I think it would be preferable to lay down four separate lines to putting two inside the others. I believe that, both as a question of safety and with reference to the cost of keeping up the plan, it would be better to lay down distinct lines of rails altogether. It would be equivalent almost to a double railway.

668. Are horses, cattle, sheep, or pigs, carried over both lines?

Horses, cattle, sheep, and pigs, difficult to transfer.

They are; and that is the description of traffic with which we have a great deal of difficulty in managing at Gloucester. We are obliged to drive them out of one cattle waggon and then drive them into another, and it is sometimes a very difficult matter, indeed, to get them reloaded. This inconvenience applies to horses very much too. If the Bristol and Gloucester line were adapted to both Gauges, the Wide Gauge line would be practically useless. It would require two descriptions of stock, and we think we can work the narrow stock cheaper. — If you make a break of Gauge, I think it would be advisable that the break should take place where the smallest quantity of goods should be trans-shipped; a remote point of the line would render the evil less felt.

Both Gauges established: Broad useless in practice.

Break of Gauge best where smallest quantity of goods are trans-shipped.

In many instances there has been a day occupied in trans-shipping. I recollect in one case we had between forty or fifty waggons standing loaded with goods at Gloucester a fortnight, waiting for Broad Gauge waggons to come up, and that may occur either way.

Fifty waggons waiting a fortnight for Broad Gauge waggons.

677. Have you not some mechanical arrangement at Gloucester for transferring the goods from one line to another?

Manual labour only used in transfer at Gloucester.

No more than manual labour and cranes. We did propose, at one time, when the line was first opened, to adopt something of that sort, either by using shifting

bodies, or by low trucks, something like what gentlemen's carriages are carried on; but on making further enquiries into the matter, and talking to other parties who had some experience, it was thought advisable not to go to the expense of that plan.

678. Would goods waggons placed upon an additional truck pass under your bridges?

Waggons placed on additional trucks could not pass under bridges.

They would not pass under our bridges. If it was done at all the truck must be made on the Broad Gauge line to carry a Narrow Gauge waggon. Then I think with the height of the bridges upon the Broad Gauge there would be room for them to pass under. I think we found that we could manage to carry with safety, allowing the rails on the additional truck to be 27 inches the rails of the line.

679. Would that give you height of wheels sufficient?

Yes, it would be 18 inches for the half diameter of 3 feet wheels.

680. What would be the increase to the gross weight by using those trucks?

To make the trucks sufficiently strong to resist the wear and tear. I think we calculated about 3 tons 10 cwt., or from 3 tons 5 cwt. to 3 tons 10 cwt. would be the weight of the truck upon the Broad Gauge to carry the Narrow Gauge. Perhaps 3 tons 5 cwt. would be enough.

681. You have at present devised no preferable mode of making the trans-shipment?

All theories of trans-shipment in practice impracticable.

No. Although mechanical arrangements may be proposed which may work perhaps sufficiently well in an experimental manner, yet when they come into practice I believe they will be found to be totally unfit for the every day traffic of a line, and must be abandoned. There are various reasons for it, and I think it may be clearly seen. For instance, we may suppose

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that the trans-shipment system was adopted, in that case it would be necessary that all the Narrow Gauge bodies were precisely alike, and all the Broad Gauge bodies precisely alike, in such a manner that two Narrow Gauge bodies should fit the Broad Gauge frame. Now at present the carrying stock of all the Narrow Gauge lines is common stock; on the clearing-house system they go through and become as it were common stock, and where it is required it is supplied; being sent from other places it may be dispensed with. But in this case the companies which were remote from the break of Gauge would be required to alter their waggons, if they intended to work at all advantageously, as they do at present, to the same construction and size as the others, in order to fit the trans-shipment system. We may suppose a train of waggons to arrive, the bodies are shifted on the Broad Gauge trucks, and the frames are left. It may happen that there are not sufficient bodies or waggons, or loading again for these waggons to go back; the frames are put into a siding until the bodies go up, perhaps they may not be again loaded to go down, so that if there is a preponderance of traffic one way or the other, the same objection would apply in this case as it did in the case of the Birmingham and Gloucester, and Bristol and Gloucester, that there would be actually a loss of capital by these frames or bodies being at rest, or standing useless for want of each other; consequently the trucks would wait more upon each other than upon work. But, independently of that, I believe there would be a risk of accident and damage to the goods. These bodies might be very well fitted at first, but we all know what severe work there is at times—a train stopping and starting on a railway, the carriages knocking against each other. I do not think they could be made sufficiently strong without incurring a great amount of weight useless and unremunerative.

Carrying stock of all Narrow Gauge lines by help of clearing-house runs through if held in as common.

Waggons would require alteration.

Loose bodies would get away from frames.

682. Do you think that the strength of the carriage and the strength of the body is increased in both cases by their being united together?

Yes, I think that it is very necessary in railway

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waggons to put in the very best materials, and the very best workmanship, and to frame them in such a manner that they will be as simple in their parts, and as substantial as we can get them. A railway waggon is exposed to a great deal of rough usage in the train and at the stations. Now this would complicate the thing so much, that I should fear a constant cause of damage to itself and to goods which were carried in it.

Railway waggon should be solid.

683. Do you think that the public safety would be endangered by having the passenger carriages to shift so that the bodies could be detached from the wheels and frames?

I think so. I think it would not be prudent to adopt such a plan in passenger carriages at all. As far as my knowledge of the construction of a carriage is concerned, I think it requires to be compactly and well built, without any shifting or dependence on parts to be fixed and refixed again. I think it is highly objectionable that such a plan should be resorted to.

Carriage should not be subject to be fixed and refixed.

684. Supposing the system existing at the Great Western terminus at Paddington were to be put into operation at Gloucester, what time would be occupied do you imagine in transferring a load of goods from one Gauge to the other by that process?

It would be very difficult to say. There is one thing which is lost sight of in that machine at Paddington. In a long train, unless by keeping an engine constantly employed to push them forward to the machine to be lifted, and drawing the others away as they were loaded, it would take a considerable time—for, supposing there was a train of twenty or thirty waggons brought up a Narrow Gauge line to be put on the Broad Gauge waggons, they would begin with the first waggon, and they would have to go back a long way to pull up the last one, and so on. I cannot form an estimate how long it might take, but I dare say that it might be done in an hour or an hour and a half. But, then, I think that is the

Lifting machine at Paddington would require a locomotive assistant.

The operation would take an hour.

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least of the evil; it is not so much the time taken in shifting. I believe the mere machine for lifting the bodies of waggons from one Gauge to another, removes a very trifling difficulty compared with the other objections. The thing can be done very well, but it is after this has been done I think the whole of the difficulty would be felt. It is merely a preparatory step to the mass of difficulty that would be encountered afterwards.

686. Will you calculate what distance a horse would have to travel having to shift 50 waggons?

Taking 20 waggons, allowing 14 feet to a waggon, it would be 5½ miles.

Economy of Working.

496. With regard to the comparative working expenses of the line, have you been able to form any opinion upon that?

I believe that, so far as the conveyance of goods is concerned, per ton per mile, at present the Narrow Gauge has the advantage. I have seen statements of locomotive expense—my friend Mr. Gooch and I have exchanged communications upon that subject—but it is difficult to ascertain, because sometimes the relative circumstances of two railways are so essentially different, for instance the price of materials and coke, which is a very important element of locomotive expense, and the arrangement of the trains, and also the gradients, and so on; but my impression is, that there is an advantage in point of economy on the Narrow Gauge, as far as the net weight of goods is concerned. I will read a statement which will perhaps explain the relative proportion of net and tare. With the same number of waggons on the Broad Gauge 135, net average 4 tons 7 cwt., there was a gross weight of 721 tons 2 quarters, and a tare of 586 tons 10 cwt. 3 quarters, making a net weight of 134 tons 11 cwt. 1 quarter. So that the Narrow Gauge with 201 tons 8 cwt. 2 quarters less gross weight, had nearly 4 tons more net. So that of course the traction per ton per mile

Difficult to ascertain locomotive expense.

Price of coke important material.

Narrow Gauge more economical as regards net weight of goods.

Example: Narrow Gauge with 200 tons less gross had 4 tons more net.

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was 201 tons more for a load, which was not so remunerative on the Broad Gauge on that quantity of tonnage as it was on the Narrow. I am giving this as the result of actual observations of the traffic on those two loads. There was no previous notice given of what was to be done, but the traffic was allowed to take its usual course, so that we might test it. It was taken during the month of June; it was begun on a certain day, and continued on until the numbers became equal, and then the weights were noted down.

Experiment the result of actual observation.

498. Can you state with certainty that those 135 waggons on each line were taken in succession, without any exception?

I can. The books will bear out our evidence?

514. You were understood to say that 135 waggons upon the Narrow Gauge carried 130 tons net; and that on the Broad Gauge, 135 waggons carried 134 tons net; so that, in point of fact, the Broad Gauge waggons do not load more heavily than the Narrow Gauge waggons?

No; in point of fact they do not; that is the result of the regular working of the traffic.

539. With equal speed and equal loads, are you aware of the relative cost of locomotive power on the two Gauges per mile?

Believes with equal speed and load, the advantage on the side of the Broad Gauge as to cost.

I could not say what the relative cost of each would be. I am inclined to believe, from all I have seen and know of the statement of expenses, that the advantage would be on the side of the Narrow Gauge, with equal loads and equal speed. That is in point of fact in the consumption of coke.

546. Would the working cost of the engine be in any important degree increased thereby?

The consumption of coke consequent upon the generation of more steam would be greater, but I think,

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compared with the work done, the amount of tons conveyed, it is cheaper to work with one large powerful engine upon a train than two small ones. We have an engine now upon the Narrow Gauge which is capable of taking 600 to 700 tons, and my engine will take 1000 tons on a level on lines of easy gradients, at a low speed, about 10 or 12 miles an hour.

A narrow engine capable of taking 600 tons; and even 1000 tons on a level.

Economy of Construction. Engines.

567. Then, as regards the cost of construction, which is another element of advantage or disadvantage, are you able to draw any comparison?

So far as making the railway is concerned, I cannot speak to that, not having had any experience of the two systems; but, in the construction of the engines and carriages, and the plant of the railway, there is no doubt that in a large carriage, for the same number of wheels and axles you can accommodate a greater number of persons; but then, to set against that, there is the greater care necessary in constructing a much larger carriage of that description, to be sufficiently strong to resist the shocks which it is apt to receive on the rail. Of course we know the larger the frame-work, the more care is required to stay and strengthen it from being deranged. A smaller one can be more substantially and effectually constructed at a smaller expense. So that, I think, on that score, and taking into consideration the strength of the materials necessary, and the proportionate stays necessary to keep it equally strong to receive the shocks they receive, the two systems may be considered as near as possible equal. But the objection of the overpowering weight of Broad Gauge carriages and waggons arises, for instance, at road stations, where a small amount of strength—for instance, perhaps only one porter—is quite sufficient for the traffic; if he had to remove a Broad Gauge waggon there, he might find it a difficult matter to move it about from one part to another, as it may be necessary to do. We find also, on the Bristol and Gloucester portion of the line, that a waggon will have to be sent away with half a ton, or one ton weight, so that there are four or five tons tare

Broad carriage expensive from extra strength required.

Too heavy to be moved by one porter.

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for one ton net. The cost of construction of the Broad Gauge waggon, compared with the amount of net weight that is to be conveyed, is equally as large as of the Narrow Gauge waggon. In fact, I am almost inclined to believe that machines for conveying a certain amount of net weight on the Narrow Gauge can be made at less expense than on the Broad Gauge. So that, so far as a capability of conveying a certain amount of net weight is concerned, there is a possibility of constructing goods carriages upon the Narrow Gauge cheaper than upon the Broad Gauge.

Machines for conveying on Narrow Gauge made at less expense than on Broad.

576. In the event of the same Gauge extending from Bristol to Birmingham, would the same number of engines be requisite to be kept at Gloucester as are now requisite there for both Gauges?

No; I conceive that the present number of working engines on the Birmingham and Gloucester, supposing the line were made narrow to Bristol, would be sufficient to work the entire line to Bristol.

Construction of Carriages.

717. Are you of opinion that the wider base of the Great Western carriages renders them steadier on the rails, and that therefore there must be less oscillation than in the Narrow Guage carriage at high velocities?

I incline to think not, because the steadiness of the carriage, from the peculiar motion given to it in drawing it on the rail, arises more from the longitudinal motion than from the transverse motion. The breadth of the carriage, I think, has not such an effect in producing a steady motion as length. If we could get carriages with ten pair of wheels, we should get something like a very steady motion, because one pair of wheels would support the other. I think the vertebrated carriage would be the best. Then the Broad Gauge carriages are shorter in proportion to their breadth than the Narrow Gauge carriages, and consequently are more apt to get angularly towards the rail. The flanges of the wheel impinge first on one side, and

Thinks the wide base of Great Western carriage does not produce such steady motion as length.

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then on the other, whereas on carriages of considerable length it has not room to acquire that so much as to shake the carriage about; so I believe the long carriage and Narrow Gauge is quite superior to the Broad Gauge and short carriage.

719. Then your objection is to the shortness of the carriage, not the breadth of the rail?

The shortness of the carriage, compared with the breadth of the rail?

720. So that, in point of fact, a carriage with an additional compartment would, in your opinion, make the Great Western carriages more perfect.

With an additional compartment. Objection, that two or three additional passengers would require a carriage of 12 tons.

But then again there would be this objection applicable to the Great Western carriage, that it would increase to such an unwieldy machine as to require a great deal of strength, at the different stations where it was taken off and put on, to move it. Besides, there is another important objection which would apply to it, and which applies now, that, supposing a train was marshalled, and there were five or six carriages all full, suppose two or three passengers more came, one of these carriages increased in that way, say to 12 tons, would have to be taken along the Broad Gauge line for the sake of those two or three passengers, so that it would render it objectionable in having a carriage of that great weight so very long for the sake of a small access of passengers.

721. That must be an inconvenience of very unfrequent occurrence, must it not?

Upon Bristol and Gloucester an additional 1st class and also a 2nd class taken all the way for two passengers.

Not so frequent as it may be supposed. It sometimes occurs that we have to convey a carriage the whole length of our line for the sake of two passengers, and upon the Bristol and Gloucester it is peculiarly felt, for we have often a first class carriage additional from this cause only, for instance on a train, and also an additional second class carriage on a train. It so happens that there may not be above two first-class passengers come up by the morning train from Bristol

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and Gloucester, and the result is that we are obliged to take that first class carriage all the way for the sake of those two passengers. Now, if we had the Narrow Gauge, instead of conveying a carriage weighing from 8 to 10 tons weight, giving 5 tons for each of the passengers, we would manage to convey them with a carriage of about 4 tons weight, so that the small carriage meets the inequalities of the traffic much better than the broad carriage, and renders the conveyance of the passengers less expensive for that very reason, in the same manner as it applies to the conveyance of goods. If you could always bring the traffic of every station up to the proportion of the broad carriage and of the broad waggon, then I should say that the Broad Gauge would be so far advantageous, but as the average of the passengers and the goods are very often below even the Narrow Gauge carriage, then we approach nearer to the requirements of it by the Narrow Gauge carriage and waggon.

Safety, curves, speed of Engines.

482. As far as safety is concerned, we have perhaps the only opportunity of judging of the two Gauges, having part of our line broad and part narrow. We have perhaps the only opportunity in the realm yet, and, for my own part, I should say that, in point of safety, I can conceive no difference between the two Gauges. I think that safety does not depend so much upon the width of Gauge as it does upon other circumstances, which we learn and judge of by actual experience, that is, from the accidents we observe on railways. So far as speed is concerned, I did think that the Broad Gauge engine, from having greater space for the working parts of the engine, might be made more powerful, so as to produce greater speed, but I am inclined now to think that there is no superiority in that respect, inasmuch as I have observed Narrow Gauge engines which have been capable of running equally as fast as the Broad Gauge. My opinion is, that with respect to the power, which is in other words speed,

Thinks in safety no difference between the Gauges.

At present narrow engines as powerful as broad.

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Power.

that depends upon the amount of evaporating surface in the boiler. If we can get as large an amount of evaporating space compared with the weight of the engine, not to make it too heavy of itself, on the Narrow Gauge as we can on the Broad Gauge, I think they would become equal in that respect. I might state my reasons for this: I have to work perhaps the most difficult part of any line in England. The Lickey incline is 1 in 37, which is a very steep gradient, and has always been worked by a locomotive engine. I found from the experience I had there, that for the last four years we were labouring under the disadvantage of having engines of so light a construction that they had not sufficient adhesion on the driving wheels, so I recommended the Directors to allow me to make an engine of sufficient power in order to test the relative economy of a heavy and light engine in working this steep gradient. I made an engine which has been at work now the last two months, with a cylinder 18 inches diameter, stroke 26 inches, and the driving wheels 46 inches, 3 feet 10 inches diameter, six wheels, all coupled. The engine carries its water in a tank on the top of the boiler, so as to give it the advantage of all the weight I possibly can to increase the adhesion of the wheels, and I think it weighs in working order somewhere about 30 tons. But such is the effect of this large engine, that I should imagine by increasing the weight of the engine, as you would have to do upon the Broad Gauge equally as well as on the Narrow, to get evaporating surface, that by so largely extending the boiler you would increase the weight of the engine itself, which might be of service in propelling a heavy train; but I think at a high speed it would not be of advantage, as it would cause the engine to be more liable to get off the rails, the rails not being sufficiently strong to resist the powerful shock received from a large heavy machine of that description moving at a high velocity. Therefore, as far as speed is concerned, I believe there is a proper medium to be observed in the weight of the engine, that is to say, to proportion the evaporating surface to the weight of the engine so as to make it a proper medium size in order to go safely

Has made an engine weighing 30 tons of great power.

Weight gives power.

Doubts if such power safe at high speeds.

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at a high speed. I do not know that we have sufficient data at present to judge of what the proper construction of an engine should be for running a fast train; but from all I have seen, and all I can judge of the engines on both portions of our line, I am not inclined to give the superiority to either in point of speed. I believe that the Broad Gauge has at present the advantage; but I do not think that the Narrow Gauge railway companies have turned their attention so much yet to increasing the speed of the engine as the Broad Gauge have, and that that is the reason, if there be a superiority, why they have it. But I believe lately there are some engines being constructed by different manufacturers which I believe will be able to travel with as high a speed on the Narrow Gauge as they have been able to attain on the Broad. The engines on the Bristol and Gloucester portion of our line I think give us a very fair sample of the most improved form of Broad Gauge engines, for this reason, that the parties who have provided the engines made also the engines for the Great Western Company, so that they have had the opportunity, all the time the Great Western has been working, of observing all the different improvements which might be made, and no doubt they have taken advantage of them in constructing the engines for the Broad Gauge of the Bristol and Gloucester.

Narrow Gauge has not turned attention to speed yet.

483. Are you of opinion that you have at present upon the Bristol and Gloucester engines of the Broad Gauge of the first class?

I think so. I think from the experience they have had of the Great Western engines since the opening of the line, the Bristol and Gloucester engines may be taken as a fair sample of what the Broad Gauge engine is capable of doing.

494. You stated that there were other elements of danger independently of the Gauge in railway travelling. Will you state to what you alluded?

I think one important danger is the irregularity of the rails, the rails being perhaps out of Gauge, or the

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joints being out of order in consequence of the key being loose, one rail projecting above another, which is liable to cause an accident. And in some cases, after long continued rain, if the ballast is not sufficiently solid, the sleepers on which the rails are, are apt to sink, and cause inequalities of that description before the people who have charge of the permanent way have had time to remedy it. Then there are cases in which accidents have occurred from neglect of the points. It is the case in some railways, and ours among the number, that there are some points leading off the main line, which face the trains, which is always to be avoided if possible, because those may be placed wrong, and that may lead to an accident.

Danger from rails out of Gauge, or, after rain, sleepers sinking from neglect of points.

521. Can you state the average size and weights of the engines employed upon the two lines?

Engines weighing from 10½ tons to 30 tons.

It is difficult to give the average weight of the engines, there is so great a variety. We have engines weighing from 10½ tons, and, including the large engine, up to about 30. Our large bank engine would weigh about 30 in working order. The average weight of passenger engines, which run with passenger trains, 13-inch cylinder engines, is about 12½ tons.

533. You stated just now that you would place an empty carriage between the passenger carriages and the engine?

Our empty carriages, perhaps, are about as heavy as a luggage van with luggage. I should not place an empty van there, but I should place an empty carriage there. If we had two luggage vans loaded we should place them there.

534. Have you availed yourself of the opportunity which your situation affords of ascertaining, with equal loads, the relative speed on the two lines?

I have a statement here which shows that very clearly, and which I was going to explain before. In this case, both Mr. Slaughter and myself received no-

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Experiments.

tice that there was to be a heavy train. For my own part I was unprepared, because I only got notice in the morning about ten o'clock, and the train had to start at two, so that it was one of our ordinary goods engines that took it. I presume Mr. Slaughter was similarly circumstanced; at all events, it was, I believe, about the most powerful engine which they had upon the line which was used. The gross load upon the Broad Gauge conveyed by Mr. Slaughter's engine was 235 tons 2 cwt., the tare was 137 tons 12 cwt., the net was 97 tons 10 cwt. On the Narrow Gauge the gross load was 254 tons 9 cwt., the tare 101 tons 17 cwt., and the net 152 tons 12 cwt. The waggons were taken and loaded expressly that there should be as little dead weight as there possibly could; and this is a further proof of the comparative net and tare upon the two Gauges. We had 36 waggons upon the Narrow Gauge; they had 25 waggons upon the Broad Gauge. Their gross load was 235; ours was 254. With 35 tons 15 cwt. less tare we had 55 tons 2 cwt. more net. On the Broad Gauge, the distance being 37 miles and a half, the load was conveyed in 4 hours 13 minutes, including stoppages.

On a trial 36 narrow waggons with 35 tons less tare had 55 tons more net than 25 broad waggons.

535. What number of stoppages?

I think there were four. On the Narrow Gauge of 51 miles the load was conveyed in 3 hours 55 minutes; this was from our Camp Hill station at Birmingham, where we have an incline of 1 in 84. This load of Mr. Slaughter's was hauled up the incline at Bristol by an assistant engine; so that, of course, that was additional. They had an incline there to be assisted up which we had not; and over all this line the average speed was about 8¾ miles on the Broad, and about 13 on the Narrow.

536. What was the number of stoppages on the Birmingham and Gloucester?

Six. In one case we had to stop to allow the passenger trains to pass us, causing a stoppage, I believe, about a quarter of an hour or 20 minutes.

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537. Do you know what the travelling speed was, irrespective of stoppages, on both lines?

I do not at present; I can easily procure it. I travelled with our engine myself, and I found that we went up two inclines of 1 in 100 at a speed of 8 miles an hour. On other portions of the line, that is, on level portions of the line, and slight inclinations, our maximum speed was 25 miles an hour. I can state the size of the engines. This is a statement I received of the size of the engine on the broad Gauge: cylinder 16 inches diameter, stroke 21 inches, wheel 54 inches, gross weight of engine and tender 23 tons. Size of engine on the Narrow Gauge: cylinder 15 inches diameter, stroke 24 inches, wheel 54 inches, weight of engine and tender 27 tons. All six wheels, I believe, were coupled in both cases, so as to get the utmost adhesion.

Went up inclines of 1 in 100 at 8 miles an hour.

542. From my experience on both lines, I think equal velocity can be obtained with equal safety on both Gauges, with engines of the greatest power now in use.

544. Greater power and, consequently, greater speed could be obtained on the Bristol and Gloucester line by increasing the boilers of the Broad Gauge engines; the evaporating surface is the foundation of the power and speed of the engine.

545. Would any risk result from such increase?

An increase of the boiler of the engine would necessarily cause an increase of the weight of the machine altogether, and it is my opinion that at a high velocity a very heavy machine would be found to act very injuriously upon the rails. It would not be felt to the same extent with a powerful engine going at a slow speed with a heavy train, but I think it would be objectionable at a high velocity; and, as I stated before upon that ground, I believe that the Narrow Gauge can be carried with sufficiently large boilers, and that as far as it is safe for the rails to increase the weight

At high velocity heavy machine injurious to rails.

and power of the engines, and to produce speed, all that can be done upon the Narrow Gauge as well as upon the Broad.

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549. Are you of opinion that the injury to the rails and the permanent way would be augmented materially by the increased weight and speed?

It would be very much increased. I believe that the injury to the permanent way on both Gauges is more caused by high velocity than by increase of weight.

Injury to permanent way much increased by high velocity rather than by weight.

550. Is that matter of opinion, or is it the result of any experiments you have made or experience you have obtained?

I have observed myself, watching the trains going over the line, that the shocks received from the fast trains appear to affect the rails more than the slow trains passing over, and that is the opinion of men who are particularly interested in it; the contractors who have the repairing of the permanent way, and who, of course, feel it in a pecuniary sense, they do not like fast trains so well as heavy trains at a slow speed.

Contractors object to fast trains more than heavy slow ones.

551. Do you know any contractor who has made it his business to inquire into that important point?

I do not: I merely state it as the opinion of those with whom I am in daily communication on our own lines, so much so that I believe they would prefer a large goods engine going over with a heavy train, rather than a much lighter engine going over it fast with a light train.

553. Are you of opinion that the present rails of the Broad Gauge system are sufficient to bear the increased weight and the increased speed?

I think it would injure them.

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554. Are the embankments and bridges in such a state as not to risk the public safety by such increased speed?

That I could not speak positively to. I think that we have now come to as high a speed as is consistent with the public safety, and I think that increasing it would be attended with very much increased risk.

Mechanical comparison of the two systems.

555. Having had an opportunity of considering the relative properties of the two plans of Gauges, are you prepared to state the advantages of both?

Small axles more likely to be sound than broad.

So far as strength of material is concerned, the increased weight of the Broad Gauge renders it more liable to accident than the Narrow. It is found that we can procure a sounder article with the smallest area; that is to say, if you increase the size of the axle there is more fear of unsound parts being in the axle of larger area than there is in the small, because you can get it more uniform and solid more in the small than in the large. On that account, if you increase the Broad Gauge axle to such a size as to prevent the springing of it to a greater extent than the Narrow Gauge you would so increase the size of the Broad Gauge axle as to incur the risk of not getting a sound one.

556. Before you proceed to the other points connected with this question, will you state what knowledge you have of the defects of axles in the Broad Gauge, or of accidents that may have arisen from those defects?

I have not seen fractures of axles on the Broad Gauge. I have seen fractures of axles on the Narrow; and there is certainly, I think, a very extraordinary change takes place on axles from the constant blows they receive, or rather from the wheel receiving so many blows. It amounts to what we call cold swedging on the anvil, and renders it more brittle, which must be, of course, to the same extent on the Broad Gauge. On the Narrow Gauge we have had axles break that have been in work three or four years; and

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although the axle in the first instance might be fibrous, as we call it, in its texture, yet on being fractured, it presented a crystalline appearance as if it had been all broken up into small crystals. Now I consider that the breakage of axles must arise generally from that cause, and it requires, I think, the greatest care in getting axles of the best manufacture, of the toughest and strongest iron to resist this.

565. Having dealt with the subject of axles, will you now go on to the other branches of the question, as they occur to you?

Speaking of axles, I would observe, that with the long bearing of the axle, of course from the elasticity it possesses being so far from the points of support, it would materially affect the wheel, and cause the wheel to be thrown out of the perpendicular, and tend to injure the railway; and, in some manner, of course the flange of the wheel, by impinging upon the rail, and forcing it out of Gauge. That, I think, would be a further objection, from the width of the bearing allowing the axle to have such an effect upon the wheel, that is to say, it extends itself further than the axle. On curves, I think, an objection arises again to the Broad Gauge, from the inner circle of the Broad Gauge being, to a certain extent, less upon the surface than the outer circle of the rails; consequently, in passing round these, there must either be a straining of the wheel, or, to a certain extent, a twisting of the axle; one wheel having to travel upon a greater surface than the other; and that, I think, will tend to a deterioration of the quality of the axle, by its being strained in this manner more on the Broad Gauge than the Narrow. On a quick curve this would be felt rather sensibly. Of course the quicker the curve, the more will the disproportion between the two surfaces of rail be felt on the axle. In some portions of the country, in Staffordshire, in the mining districts, there are some lines about 2 feet Gauge, where they are able almost to turn at right angles; whereas, with a Broader Gauge, it would be impossible. We have a

Curves an objection to Broad Gauge.

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curve in our line of 8 chains radius, going from Camp Hill out of the Birmingham Station; and on that curve, if there was a 7 feet Gauge, I think the injurious effect would be much increased.

568. It appears from your last answer that you think the Broad Gauge not equally suitable for lines of severe curves?

I think not.

569. Are both, in your opinion, equally suited for lines of severe gradients, supposing the driving wheels to be such as those upon the Great Western?

I think the Narrow Gauge is better adapted for severe gradients, supposing the driving wheels to be of the same dimensions.

570. Will you state why?

With the engines we are now using on the Narrow Gauge lines, with severe gradients, we make it our study to keep the centre of gravity as low as possible, and to make the engine-wheel of as large a diameter as we can generate steam for; and I think that, on the Narrow Gauge, we can go as far as the Broad Gauge people can in providing a maximum engine, perhaps as large a one as it is prudent to put upon the rails for steep gradients. High velocities on the Narrow Gauge, as compared with the Broad Gauge, I believe would not have the effect of increasing the expense so much in the narrow as in the Broad.

Can go as far as Broad Guage in providing maximum engine.

689. And why?

Because the machine would be lighter on the rails going at a high velocity on the Narrow, and not have such a tendency to damage the rails.

694. Are you aware of the improvements that have been lately made in the engines on the Narrow Gauge lines, and can you describe those improvements?

Mr. J. E. M'Connell.

The two schools of locomotive manufacturers.

There have been two schools of locomotive manufacturers, each advocating their own system. I may describe the general features of both. Mr. Robert Stephenson has always, I believe, advocated the six-wheel engine, and has made it; he has improved it very much; he has simplified the arrangement and construction of the engine; he has adopted the outside cylinder to his passenger engines, with a framing rivetted to the boiler plates; and he works his solid valves in a vertical direction. He has very much increased the length of the boiler. I think the average length, before it was varied by Mr. Stephenson, was from 8 to 10 feet, and now Mr. Stephenson has adopted the 12 feet tube and upwards, thereby safely calculating that a very great economy is effected in the consumption of fuel, that is, that a less proportion of heat is allowed to escape unprofitably up the chimney. This engine is found to answer in practice exceedingly well, inasmuch as it gives a greater length of engine on the rails, and, I think, increases very much its steadiness at a high speed. He has also a patent for placing the whole six wheels between the fire-box and the smoke-box, whereby he is enabled to distribute the weight more equally on the wheels. In working the engine he also uses what is termed the expansive motion, the link motion. It enables the driver of the engine to regulate the supply of steam to the cylinder in proportion to the load. There are various plans of doing so. There is a plan proposed and patented by a Mr. Bodmer, of Manchester, and Mr. Myers, of Mulhausen, on the Continent, for doing the same thing, all tending to the saving of steam, and providing the quantity of steam requisite to overcome the load. The size of the engine is increased. At one time it was considered that from 12 to 13 inch cylinders was a good average size for working railways. Now we find from experience that economy of working is very much assisted by taking the train by one heavy engine instead of two light ones: that is to say, you save the wages of two men; and, I think, the expense of repairs

Stephenson's long boiler locomotive described.

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is very much reduced, and materials, for instance, oil and tallow, &c., and the consumption of coke in the one engine is not at all equal to the consumption of the two, which would only do the same amount of work. Now, I believe, the practice has become general on Narrow Gauge railways to adopt 15-inch cylinders instead of 12-inch, and even higher than that. There are at present engines being made at Messrs. Sharp's manufactory at Manchester with 18-inch cylinders of nearly the same size as the one I have at work at Bromsgrove, but with 24-inch stroke, 4 feet 6 inches driving wheels. They are intended for the Sheffield and Manchester Railway, and the Manchester and Birmingham, and it is calculated they will be of very great service with heavy goods trains, and enable them to carry at a very low cost indeed. I have no doubt those engines will be equal to take 800 tons, and travel with ease when they are at work; proving that, so far as the power of an engine is concerned, the power of getting machinery on a Narrow Gauge is sufficient to take any load; it will be quite equal to produce it, at least as far as it can be properly adopted without increasing the weight of the machine to the injury of the permanent way. Our power is increased more than it would be warrantable to increase the weight of the machine, of which the engine I have at work is an instance; for although it is 30 tons in weight, I can make the whole six wheels spin round and slip with the six wheels coupled. I think that settles the point completely, that we can get sufficient power on the Narrow Gauge, without at all injuring the construction of the engine, or rendering it objectionable. I may state with respect to those engines that are in construction by Messrs. Sharp at present with the 18-inch cylinder, it is a most remarkable thing that the cylinders are not placed outside the wheels, but inside, so that there is room for two 18-inch cylinders in the Narrow Gauge to be constructed inside the wheels, working with the crank shaft.

New engines for heavy goods trains.

Mr. J. E. M'Connell.

695. Does that affect the centre of gravity?

Not much; the cylinder is kept low; the valves are underneath in this case. The principal objection is the crank shaft, to get room for the boiler; but on the drawing and on the elevation of the engine, the centre of gravity does not seem to be at all too high.

Mechanical description.

696. Have those engines four eccentrics?

Yes; and they are to be worked with the link motion of which I have spoken.

679. Are they completed, or in progress?

They are in progress; they are pretty far advanced. I believe there are four for the Manchester and Sheffield, and two for the Manchester and Birmingham.

698. Does any defect present itself to your mind in the construction of these engines, countervailing the advantages?

Not at all. In fact, I am well pleased with the construction of the engines altogether.

699. You have examined them?

Yes; I have had the parties up at Bromsgrove, where my engine was under construction, and we discussed the matter fully. They found in their ordinary practice that it was advantageous to employ large engines of this size; they were led to it; and I have very little doubt that the Narrow Gauge railways will find it to their interest to adopt that size of engine for the conveyance of goods; that it will be a source of great economy, and enable them to reduce the rate o goods very much to the public, by carrying them so much lower. I also think it is as great a weight of engine as it would be at all prudent to put on rails either of the Broad or of the Narrow Gauge.

Heavy engines will be adopted for the conveyance of goods.

700. What is it intended that it shall weigh?

I believe somewhere about 25 tons.

Mr. J. B. M'Connell.

701. When charged?

When charged.

702. Do you speak of the engine alone, or the engine and tender?

The engine alone; and, travelling at a speed averaging from 12 to 20 miles an hour with a goods train, I think it is quite as fast as it would be at all safe to go with the weight of the engine on either Gauge.

703. Will these engines be used at all for the passenger trains?

I think not; the wheels are only 4 feet 6 inches diameter.

704. They want adhesion as well as power?

Yes.

705. You said there were two systems of engines in construction, and you described Mr. Stephenson's; will you proceed with the other?

Description of Mr. Bury's four-wheeled engines.

Mr. Bury has always been a maker and supporter of the four-wheel locomotive engine. They are in use on the London and Birmingham Railway and several other railways. They also have been much improved: the boilers have been lengthened to about 11 feet, I think; they have been increased in size with 15 inch cylinders and 2 feet stroke. I saw, I believe, the last improvements on one of the railways; and, certainly, it was a very good machine. The engine is not so heavy as that I have described, but the construction is good; it is a very compact good engine.

706. What is the interval between the fore and hind axle?

I think it is somewhere about from 6 to 7 feet.

722. I should imagine if that weight were kept low, and if the centre of gravity were as low in the carriage

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as it could be got, it would; but in order to get the wheel in proportion to the size of the carriage, the Great Western carriages have their centre of gravity, I do not say disproportionally high, but it is up; and when the rocking motion does commence, it is really terrific, more so than it is on our line.

Description of Bury's four-wheeled carriages.

725. And where are the centres of gravity?

I really cannot tell where the centres of gravity are, I only judge from the actual oscillation of the carriage; I find it much more on the Bristol and Gloucester than on ours.

726. Is it not an admitted fact that, other things being equal, the lighter the carriage the more liable it is to leave the rails when running at high velocities?

Light carriages liable to leave the rails.

So far as jumping is concerned, certainly the lighter carriage would be more liable to leave the rails; but then, I think, taking into consideration the length of the Narrow Gauge carriage, as compared with the less breadth, and taking the length of the broad carriage as compared to its breadth, that the liability to leave the rails would be greater on the Broad Gauge than on the Narrow Gauge at a high velocity, assuming the velocity to be the same on both cases. I think that, owing to the disproportion of the length to the breadth, it would be so.

735. Have you any experience which enables you to say whether the axle is more liable to break with inside cylinders or with outside cylinders?

I should prefer the straight axle with outside cylinders, so far as the safety of the axle is concerned. I may observe that the liability to its giving way is the principal objection to the crank axle, and it is not so safe.

Utility.

687. Are you sufficiently informed of the mineral district of England and Wales, to be able to give an opinion of the preference that would be given by the coal-owners and miners to one Gauge, or the other passing through or near their mineral property?

Miners work Narrow Gauge more conveniently round pits with sharp curves.

I have heard the opinion of several miners who have had experience in working those mining lines; and I believe the whole of them, without exception, give the preference to narrow lines, for the reason I before stated, that they can work them more conveniently round their different pits with sharp curves, and the Narrow Gauge line conveys sufficient mineral for them to draw with their horses; so that it would be useless to make it broader, and increase the tare-weight of the machines.

Mr. J. U. Rastrick.

August 12th, 1845.

JOHN URPETH RASTRICK, Chief Engineer of the London and Brighton Railway.

Uniformity of Gauge.

889. You are of opinion that the change of Gauge is an inconvenience?

It would be extremely inconvenient.

890. Both to passengers and goods?

I mean that the change of Gauge on these lines* could not be made, because it would involve the change of Gauge on all the other lines with which they are connected; but if you refer to the proposition of making the railroads for which I have lately obtained the Acts of a different Gauge, I should say it would be very inconvenient. All these lines are of course, in some measure, branches into other railways; and it could not be endured for a moment that the trains should be stopped at all those different places where the connexion is made, for the purpose of changing from one Gauge to the other.

891. Should you consider it a great evil to the general traffic of the country if the Grand Junction Railway Company were to change their Gauge to the Broad Gauge?

I think so. It would involve a change of all the railroads in the north of England.

892. It would put the public to inconvenience?

Undoubtedly.

Break of Guage and Remedies.

896. What would be the inconvenienc at Rugby on the Midland Counties in that case?

Business could not be carried

I do not see how the business coul be carried on

* The Lynn and Ely, Lynn and East Dereham, Gravesend and Rochester, Three Bridges and Horsham, Brighton to Hastings, Lewes to Keymer Lines, &c. &c.

Mr. J. U. Rastrick.

with any sort of expedition if you changed from one Gauge to another either at Rugby or at any other place. There must be delay and great inconvenience attending the change of goods from one carriage to the other.

on at Rugby with Break without delay and inconvenience.

897. Have you any knowledge of the system adopted in the North at one time, of the loose box for coal to be transferred from carriage to carriage?

Yes. When we first began to work the Brighton Railway, I had some of them taken down there on purpose to try the experiment; we had loose boxes; two boxes were put on each carriage, and the coals were put into them. It was then thought that if the loose carriages were lifted off the waggon and then put on a pair of wheels, they might be taken to the town; but the contrivance was never used to any extent, being found very inconvenient. They were square boxes; there were small wheels underneath, and there were a couple of flange rails laid for each carriage; they were pushed on sideways, and the other carriage was backed up to it. We never prosecuted it to any extent, because it was found extremely inconvenient. I think we had four carriages of that description made.

Loose boxes tried on Brighton Line for coal;

were found inconvenient.

Construction of Engines.

926. What is your opinion of the effect of outside cylinders, do they produce any yawing motion?

Outside cylinders do not produce yawing motion.

Not the least in the world; it is impossible any such motion can be produced, unless there is a play in the framing itself.

928. If the crank was pushed by a person standing on the ground, or from the ground, might it be pushed above?

Certainly; but so long as the whole is connected together, I do not see what chance there can be of its throwing it sideways, or making oscillation sideways. I consider the outside cylinders to be very much preferable to the inside cylinders.

Mr. Robert Stephenson.

August 6th, 1845.

Mr. ROBERT STEPHENSON, (son of George Stephenson, the Chief Engineer of the Manchester and Liverpool Railway), Civil Engineer; Engineer of the London and Birmingham and Midland Counties Railways, &c., &c.; a Manufacturer of Locomotives, Coal Mine Proprietor, and Practical Miner.

Uniformity of Guage.

The Narrow Gauge adopted on the Leeds and Grand Junction, in order to work into the Liverpool and Manchester.

Adopted on North Midland and Manchester, and Leeds and Derby Junction, and London and Birmingham Great North of England, and others, to obtain uniformity.

12. The Gauge of 4 feet 8½ in., was adopted by the Leeds and Grand Junction Railways, because, after the Liverpool and Manchester had been established, it was quite apparent that all lines in that neighbourhood must work into it, in order to get to the port of Liverpool. In fact, it was considered imperative that the Gauges should be the same.

I proposed the same Gauge for the North Midland, because it was a part of the line common to both the Manchester and Leeds and the North Midland; and the Manchester and Leeds having been fixed with the view of eventually working into the Manchester and Liverpool, of course it became equally a matter of consequence that the North Midland should be of the same Gauge. I also fixed the Gauge of the Derby Junction at 4 feet 8½ in., it being, in point of fact, a continuation of the North Midland to Birmingham. The Gauge of the London and Birmingham is the same. My principal reason for adopting it was to obtain uniformity of Gauge. I was not responsible for the Gauge of the Great North of England, but it was imperative that it should be of the 4 feet 8½ in. Gauge, because it was to work into the Stockton and Darlington, which was already in existence at one end, and the York

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and North Midland at the other. A break of Gauge has always been looked upon as so great an evil that the question of adopting a different Gauge has hardly ever been ventured upon in the North.

Adopted a five-feet Gauge on the Northern and Eastern Railway, to be in uniformity with Eastern Counties. Blackwall Railway laid down on same Gauge for same reason.

62. The Gauge of the Northern and Eastern Railway, of which I am and was the chief engineer at the time of its construction, was 5 feet, in consequence of its being brought into connection with the Eastern Counties, which had, at that time, been laid down with the 5 feet Gauge, by Mr. Braithwaite. I, therefore, adopted the 5 feet Gauge, to be in harmony with it, and with the same view I laid down the 5 feet Gauge upon the Blackwall, because I considered that it might hereafter be extended; and being on the same side of London, I thought it would be impolitic to run the risk of not having a convenient connection hereafter, if it should be deemed necessary.

These railways altered to 4 feet 8½ in., to avoid separate establishment for transfer of goods at break of Gauge.

Those Railways no longer retain the original Gauge of five feet; they have recently been altered under my direction. When the extension of the Northern and Eastern was considered, it became apparent that any line extending to the Northern and Eastern Counties must have lateral communication with existing lines of Railway, on the four feet eight and a half Gauge, in the Midland Counties, and the inconvenience of the change was fully considered. I was strengthened in the opinion that the alteration was necessary, from foreseeing that wherever there was a cross line of railway having communication with the Midlands, the inconvenience would be multiplied; that, in fact, nothing could pass from one line to the other without an absolute transference, and that an establishment for that operation would have to be kept at every point where the change would take place.

After having decided upon altering the Northern and Eastern, which was the only one leading into counties already occupied by the Narrow Gauge, it became a question whether we should alter the Gauge of the Eastern Counties, which was laid down for fifty miles, to Colches-

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ter, into a district of country where the junction of different Gauges would have been of less consequence, because apart almost from any other line in the kingdom, running through quite an agricultural district, having little or no communication with the manufacturing districts. We considered the feasibility of working that line with a five feet Gauge, by laying a third rail down from Stratford to London, a distance of three and a half miles. I found it was impracticable to adopt a third rail, when we came to consider the combination of the two Gauges in the station at Shoreditch. I could not devise any means by which we could work it. There was another reason for altering it. We found that the two lines would require two completely separate carrying establishments. We could never make use of the carriages of one line upon the line of the other; which we find to be of vital consequence, because it materially lessens the cost of carrying establishments. For instance, in the two cases, of the Northern and Eastern Counties, on market days or race days, or particular seasons, when a flood of traffic takes place upon the Eastern Counties line from Colchester, it does not take place simultaneously on the Northern and Eastern, therefore all the carrying establishments on that line may be immediately transferred to the other line, in order to meet the exigencies of the Eastern Counties, and *vice versâ*; whereas, if they had two carrying establishments, I consider they would have spent far more money than they have in altering the Gauge. The cost of altering it was 52,000*l.*

A third rail within the 5 feet Gauge, for Narrow Gauge carriages, found impracticable.

Two lines require two carrying establishments.

Uniformity of Gauge enables Railway Companies to borrow carriages from neighbouring Companies when an increase of business occurs.

To effect the alteration involved the necessity of working upon a single line of rails. We had to divide the establishment into two parts, one of which we retained as available for the 5 feet Gauge, whilst we altered the other half to be ready to work upon the line, which had been converted into the 4 feet 8½ inch Gauge; therefore the alteration from one to the other was to take place in one night, in fact, between two trains, the last at night, the first in the morning. We altered one line in parts first, but the whole in the end. Of course,

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there were a great number of precautions necessary to prevent a collision, in fact, the principle of the arrangement was working for some time on a single line.

The whole distance altered was eighty-eight miles, and the Goods Train was only stopped for two nights. The whole operation occupied about six weeks. Before we began to alter the machinery, we were obliged to have all the duplicates prepared to put on in the shortest time. For instance, if an engine was converted, the wheels were all ready, and a pair of new wheels was prepared to be put on when the old wheels would not do. We had duplicate wheels for the carriages, almost one quarter were new wheels and axles of 4 feet 8½ inches, which were put under carriages that had been used for the 5 feet Gauge. The whole expense was 52,000*l.* there were no new rails obtained at all. With respect to the York and Scarborough Railway, I proposed the 4 feet 8½ inches Gauge, although the traffic to Scarborough is not such as to make the transference of luggage and passengers a great evil if it had been found desirable to alter the Gauge, but it would have required a separate carrying establishment, whereas now the carrying establishment of the York and North Midlands, by a very slight increase, became capable in conjunction with that line of working the fifty-miles more of railway. I do not suppose they have increased the carrying establishment there by 5,000*l.*

Narrow Gauge adopted on York and Scarbro', because a slight addition to York and North Midlands worked it, a new Gauge would have required a separate carrying establishment.

174. Suppose it should be the determination of Government or Parliament that a change should take place in the Narrow lines, to make them conformable to the Gauge of the Great Western, can you give this Commission any idea of the cost of altering the engines and stock of any one line,—say the London and Birmingham ?

I should say you have a fair example of that in the case of the Eastern Counties : that was 90 miles, and it cost about £800 a mile.

There was a reduction in that case, and here is an extension? — Mr. Robert Stephenson.

Yes; I beg your pardon, I merely meant a contraction. I will give some notion to-morrow. It would involve the pulling down of the Wolverton station, which alone cost £200,000. — To extend Narrow to Broad would pull down Wolverton station, which cost 200,000*l*.

197. Are tunnels required of the width of 24 feet?

The Great Western requires at least four feet more.—They say six feet more. We require as a minimum four feet between our two lines of rail. There is, at present, width just sufficient for a man, supposing him to have nerve enough, to stand between the two rails, supposing two trains to meet. You could not reduce the space at all; because you must have a place for a man to be safe. If you took off two feet in the middle, and two at the side, a man could not, by possibility, save himself. At present he lies down on the outside of the rail next the wall: he is safe enough there. If any diminution were made in the side space it would be fatal. I did think, originally, of constructing our tunnels with recesses; but when I became more conversant with the difficulty of constructing even plain tunnels, I gave up the idea of complicating them with recesses. Besides, a man might get where he was not near a recess when the train came. I consider it quite impossible to place the London and Birmingham on the Broad Gauge: it could not be done without enlarging our tunnels, and that would be tantamount to closing the line for two or three years. — Broad Gauge requires six feet more width in tunnels than narrow Gauge. — Space in narrow Gauge cannot be reduced with safety to policemen or workmen.

176. You spoke of the complexity which would have been introduced into the Eastern Counties station if both Gauges had been carried into it. Would that complexity have been equally great if there had been a greater difference between the two Gauges?

It would not have been so great, but would have been great. We should have been obliged to abandon the turn-table system, which is a most invaluable machine in

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a railway station; it enables you to perform the operation of moving trains about with the least possible amount of labour and time.

Break of Gauge.

The break of Gauge least inconvenient where least traffic occurs.

35. It is a difficult thing to say where a break of Gauge would be of the least consequence, because it involves the consideration of where is the minimum line of traffic. When the question was broached last year as to where the change of Gauge should take place between Birmingham and the Great Western, it occurred to me that if I could draw a line somewhere between the two main trunks across which the minimum amount of traffic would pass, that would be the point where the public would suffer the least inconvenience from the transference of goods; in point of fact, in many cases, the transfer would be *nil*.

Would run carriages direct from London to Edinburgh and Glasgow.

82. Suppose a railway carried on the east side of England from London to Edinburgh, should you consider it advisable to run carriages from Euston Square to Edinburgh and Glasgow without changing?

Decidedly.

It is intended to run trains through direct from Euston station to Holyhead harbour.

90. I am the chief engineer on the Chester and Holyhead Railway. I propose to use upon that line the 4-feet $8\frac{1}{2}$ Gauge; it is intended to run the carriages from Euston Square to Holyhead direct; that of all others will be the line upon which the objection to change would be the most severe, because it would interfere with the communication with Ireland.

Meeting of Broad and Narrow Gauges serious inconvenience. Would give canals a preference, if traffic heavy.

Wherever a meeting of Gauges takes place, it must create a very serious inconvenience, in fact it is tantamount to asking the Great Western or the London and Birmingham Company to move their passengers at Wolverton. If it takes place in the midst of a great traffic it would, I believe, give canals or any other existing mode of communication a great advantage over railways. I stated in

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my evidence before the Wolverhampton committee that from Rugby, to which point it is proposed that the Wide Gauge should come, the Derbyshire or Leicestershire coal owners would inevitably send their coal by canal in preference to changing the Gauge, because they would have to transfer their coals there. It is proposed, in order to avoid the actual removal of the coals, to move them in boxes, and to have loose bodies to the waggons. Now that is a system which has been tried over and over again, and which has always failed. It was tried on the Liverpool and Manchester line originally. There was a great coal-pit about 200 or 300 yards from the line of railway; they wanted to send coals to Liverpool, and small waggons were placed on the back of large waggons and carried to Liverpool; that was soon abandoned. Loose boxes were tried at Bolton for the purpose of leading the coal into the town by horses without changing at the station; they were eventually abandoned. I tried the same thing at Canterbury, and we were obliged to abandon it, because sometimes we had loose boxes and we had no frames, and sometimes we had under frames when we had no boxes, and we could not fit them in. It is almost impossible to make this intelligible to any body who has not come directly in contact with the inconvenience of the system. Rather than introduce the loose box system, it would be far better to move the coals by hand from waggon to waggon, because there would be an end of it. When the body of the waggon is made at the same time with the frame, it strengthens that frame, and the body also; but when they are made to separate, they are both of them weak, and they both get ricketty, and are exceedingly costly to maintain in repair. On the Midland Counties the loose-box system was tried where the Erewash joins the Trent. The coal field there had the accommodation of a canal—the canal comes to the junction of the railways between Derby and Nottingham —they had cranes put up for the purpose of lifting the boxes out of the boats—it was very well and conveniently done; but shortly after they were obliged to abandon it.

Loose boxes.

System of loose boxes for carrying coal tried on the Liverpool and Manchester Railways, at Bolton and at Canterbury, and abandoned commercially as impracticable.

Tried on Midlands at Erewash, and abandoned.

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111. Does not that rather argue a want of good management than a defect in the system?

All the coal owners themselves were deeply interested in carrying this out well. The boxes were made of wrought iron, of the best possible workmanship; the mode of shifting them was simple, but not so efficient as it might have been; but it was not the difficulty of moving them, but the loose box system itself was objectionable, because the frames arrived without the boxes, or the boxes without frames being ready to receive them at the end of the journey; they could not be always kept at a particular point; and then, when the empty box came, the canal barge was not there to receive it. You could not contrive a system to work so much like clock-work as that system of loose boxes really implies; it implies that all parts of the system shall work in perfect harmony. The loose box system involves the necessity of increasing the number of carriages very materially.

Loose box system objectionable. Frames arrived without boxes, and boxes without frames.

Involves necessity of increasing number of carriages.

113. What system was adopted at the Erewash with reference to the carriage of coals?

They were obliged to send them by canal; they could not avail themselves of the advantage of the railway. At Newcastle, where it is a great object to get the coals to London without breakage, and as large as possible from the collieries, they erected machinery of the most perfect description, which was devised by some of the most experienced men in the coal trade, for the purpose of conveying waggon loads direct to the vessel, instead of trans-shipping from the waggon to the keel,* and from the keel to the vessel; but they found something so inherently defective in a system in which one part depended so completely on the other, that they could not work the plan out, and it was abandoned. The Hetton Company, and some other companies, tried it. It was a plan of carrying the coal boxes in waggons, and lifting

Tried at Newcastle-on-Tyne, between pits and collier ships, and failed, in spite of excellent machinery.

* Newcastle term for a river boat.

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them by a very beautiful machine; it was unexpensive, and was done almost with the nimbleness of a hand.

117. You said, in answer to a former question, that the coal proprietors would prefer transferring their coals from the Railway carriages at Rugby by canals, rather than into a fresh Railway carriage?

Of course the transfer in the one case would be the same as the transfer in the other; but if the loose box system were adopted, the coal owners would then prefer the old system of transferring coal into keels to the loose box system, where they would sometimes have the frames without the bodies, and the bodies without the frames. The bodies would get away from their place on the line of Railway without the carriage with it. You would not have any control over it. The object of the loose box system is to avoid the transfer of bulk from waggon to waggon; and I say that it would entail so much of inconvenience upon the coal owner, that he would prefer abandoning the loose box system, and submitting to the transfer by hand.

Transfer by land preferable.

133. Have you seen at the Great Western Terminus at Paddington, any of the modes exhibited there by which it is proposed to supersede the necessity of removing goods or passengers from one carriage to another at the point of junction with a different Gauge?

Yes,—I have.

Great Western machine for transfer of goods at break of Gauge.

134. What is your opinion of those expedients respectively?

I believe the expedient would answer the purpose, as far as machinery could answer it, but the objection that I urge to the change of Gauge is not to the mode of lifting, that is a small part of the consideration in my mind; but even there I think that it is not free from

Would answer as a mode of lifting. But that a small part of the difficulty.

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objection: to any one going there to see one or two loaded waggons brought into the place, and transferred by a few men merely moving them backwards and forwards, it does not at all convey the real amount of inconvenience, or the real amount of labour which would be required to transfer a train, say of 100 coal waggons, and many of our coal trains consist of about 80 or 100 waggons.

135. Will you go through the process with reference to any particular station, and state the time likely to be occupied, the inconvenience and the expense?

We will imagine ourselves to be at Rugby, and the two lines are drawn up parallel and opposite to each other. We commence by moving the leading box on the line on to the waggon of the other line, which must be empty. We will suppose on the other line a series of empty frames, if the train is 100 waggons long, and each waggon 4 yards, that is 400 yards. This leading waggon as soon as it has got the transfer made must be dragged away by horse or some other operation 400 yards along the line. Then the next frame requires to be brought up to the next full box; the waggon requires of course to be moved precisely the same distance, minus the length of the waggon at the far end, and this operation has to go on waggon by waggon. Supposing horse-power to be employed, it is quite evident that supposing the waggons to be taken singly, the horse has to go half a mile, as near as possible. Therefore, supposing that to be done by a horse and man, to transfer a train of waggons would require the horse and man to go over 50 miles; that is quite clear, and the same will apply to the empty frames from which they have been trans-shipped, making in all, 100 miles. The other way of doing it is by engine power; that, of course, would be the alternative, and would be assumed to be the cheapest. To move 100 waggons by an engine, the train must be moved only one waggon distance at a time; therefore the engine has to start the train and stop it 200 times. Now, starting a train of

Detail of process of transferring 100 waggons at break of Gauge.

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waggons of coals and stopping it again 200 times would very soon destroy the frame of any waggon that I ever saw in my life; there is no waggon sufficiently strong to withstand that operation long. Therefore if you employ engine power for the purpose of saving the apparent impossibility of the horse and man doing it, you then ruin the waggons, destroy their squareness, and the waggon ought to be as much taken care of as the locomotive engine. Therefore, if you employ the engine, the mere operation of stopping and starting the train would occupy a very great length of time independently of the time occupied in lifting the goods. The lifting of the goods which is shown at Paddington is a mere mechanical operation. You might even imagine it to be done by magic. Still the evil remains; and I object to anybody's attention being directed to the machine, because the machine has nothing to do with it. The *modus operandi* would be such as to render it commercially impossible.

Lifting at Paddington a mechanical operation. The evil remains.

136. There is another mode of transferring from one line to another, to which you have not referred, by running the train upon another set of trucks?

Broad truck for narrow carriages.

That is another modification of the loose box system, which would increase the dead weight drawn upon the Wide Gauge so as to be highly objectionable. At present our coal waggons weigh about two and a half tons, and they carry about five tons. Ten tons of coal, therefore, upon the Narrow Gauge Railway would be contained in two waggons, each weighing two and a half tons; that would be a weight of fifteen tons. Then you are to transferthat upon the Wide Gauge truck, which in itself would weigh four or five tons more. Supposing that to be the case, you would make a load of twenty tons with ten tons of coal. You cannot get two ordinary coal waggons of the Narrow Gauge on to the Wide Gauge truck. You may have two boxes transferred, but not two waggons; therefore, the proportion of gross to net weight would be fifteen tons to five tons. If you turn your attention from coal, which is the simplest case to

Running a Narrow Gauge truck on a Broad, a modification of the loose box system. Would make 10 tons of coal a load of 20 tons.

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goods, then you get goods which are as high at present as can get through the bridges, and you would not be able to get through the bridges on the Wide Gauge, because they would be raised at least three feet higher. The bridges on the Great Western Railway are about the same as ours, about sixteen feet. Goods waggons, when loaded, are about ten feet six inches or eleven feet high; sometimes they exceed that. A London and Birmingham goods waggon properly laden, when placed on the Great Western truck, could not pass under their bridges. With respect to another expedient of the Great Western Railway, for diminishing and widening the Gauge of wheels, I do not know why, if substantially made, it should not be safe; but I think it would not keep in good order; it would be liable to derangement, and in that we might risk the safety both of goods and passengers. It is a complicated machine, where a simple one would do; it requires very great attention, would be an expensive arrangement, and one that I am most decidedly of opinion could not be kept in good order. A certain modification of it has been tried over and over again—that is, loose wheels; but after doing it in the most perfect way that hands can do it, you never can keep them in order, from the wheels being guided into flanges, there is a continual jarring motion, and invariably it wears the wheels larger.

Goods would be too high to pass through tunnels.

Telescope axles dangerous.

156. Is there not some arrangement at Birmingham by which goods are lifted from the Derby Junction to the Grand Junction or Birmingham line?

Yes, we have in a great many cases adopted lifts in those Railways at the termini where the loading and unloading of goods takes place at a level different from that of the main line, and where, of course, some delay always arises. Now at Birmingham the lift is used at the intermediate part of the line, where each waggon has to be separated from its neighbour, and lifted up and rearranged: thus it is the simplest operation for the transfer from one line to another; but if, in addition, you had to put them on different waggons, the evil, of course,

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would be very much aggravated. But even with regard to Birmingham, where it is a simple operation by lifting, which in all cases is most easily affected, so great is the inconvenience, that we have applied to Parliament this year, and intend to go to Parliament next year, for further powers to make the communication continuous, so that we are to abandon the lift, though it is employed for the simplest possible operation; but the fact is, that, occurring in the middle of the line, and preventing the train going from the Grand Junction right away to Bristol, we are now going to make a communication from that line, by means of an inclined plane, into the Bristol line.

Description of use of lift at Birmingham and Derby Junction.

172. I am decidedly of opinion, that the public safety would be endangered by having the bodies of the passenger carriages moveable at the change of the Gauge, because there are a great many slight collisions —not absolute collisions—in which danger takes place, and the momentum of the bodies would throw them off, and you have to run the risk of the porters, or whoever may have the charge of them, actually seeing that all the fastenings of each carriage are in perfect order, which would, in fact, add to the many operations we have at present to attend to in conducting Railways, whereas we ought to aim at reducing them.

Moveable bodies.

Thinks passenger carriages unsafe if bodies made moveable.

179. Supposing that it were considered indispensable to adopt some arrangements by which the traffic of the Narrow Gauge lines would be transferred to the Broad Gauge without unpacking, by what means do you suppose that object could be attained with the least cost, loss of time, and risk to public safety?

I believe the least evil is to change the goods from one system to the other by hand. Between Mr. Brunel and myself there is very little difference of opinion on that point, because Mr. Brunel says "I propose this machine only for the purpose of moving coals and things that may be packed in a simple box, like a coal box." With reference to general merchandize, I heard Mr.

Mr. Brunel only proposes Lift for coal-boxes, &c.

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Brunel express his opinion, decidedly, that it would have to be transferred altogether.

182. Do you think the Narrow Gauge carriages would run with more security upon a pair of rails within the rails of the Broad Gauge, or by using one line of rails on the Broad Gauge, and another line laid down expressly to serve the Narrow Gauge?

Considers a pair better than a single rail within the Broad Gauge.

I believe it is better to have two additional rails: there is greater simplicity in it than in mixing the Gauges. Then you might have the Broad Gauge carriages running with the Narrow Gauge Trains, or *vice versâ*, provided the buffers were arranged, which could not be the case if you had only a third line, because, then, the centre of gravity could not be on one line.—The line of thrust, or central line of carriages, would not be opposite each other.

A double line would cost about 4000*l.* annually.

185. Upon a rough calculation, a double intermediate line of rails would cost about £4000 a mile, and I think Mr. Brunel estimates a single additional line at £2500, which I consider rather within the mark; besides, the extra cost of station should be added.

207. With reference to the present and future meeting of the Broad and Narrow Gauge lines, do you anticipate much interruption to the express and other passenger trains at the point of junction?

I apprehend that the interruption will not be serious, supposing the change to be made at the proper places. I think Bristol and Oxford are two places where the two Gauges ought to meet. My reasons are based upon the fact, that I believe that at those two points there is the least quantity of cross traffic.

Now the existence of canals is, in some measure, a guide for ascertaining where the least amount of traffic does take place.—The end of the canal system for the manufacturing districts of this country, is Oxford on the one hand, and Bristol on the other; that is including,

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of course, the Severn navigation. There is no canal communication beyond that going across the Great Western Rails, North and South, clearly indicating that the country lying to the South of the Great Western Railway has little or no commercial affinity with the country lying to the North of it. Now what is the nature of the country lying to the North of the Great Western Railway, beginning at Oxford, and going on to Bristol? It is entirely an agricultural country: its corn has to go to the manufacturing districts of this country, and there they have to be supplied, as they have been hitherto, by means of the Oxford Canal and the Severn navigation, with coal, or by the one bringing Staffordshire coal to Bristol and Gloucester, and the other bringing both the Staffordshire, Leicester, and Derbyshire coal down to Oxford, where the two coals meet. The Thames then becomes the great commercial thoroughfare for that part of England, and above. All those living on the Thames receive their coals from London; therefore, Oxford, or a few miles over or under that, would show the point where the canals have met before. Then the same kind of reasoning does not apply to Bristol; but a more potent one applies, I think, viz., that it is a port, and one of the great ports, of this country. The produce, therefore, of all the manufacturing districts have their outlet at Bristol; they necessarily change from one description of conveyance to another; and there is a stop there, and I think that is more conclusive than even the other. Knowing the country well, I feel equally convinced that Oxford is the proper point. Bristol,* I think, there can be no question about: it is the port for Staffordshire; it is the port for

Country between Bristol and Oxford entirely agricultural, exchanges corn for coal of Staffordshire, Leicestershire, and Derbyshire.

Bristol the port for Staffordshire, for Manchester, and the West Riding of Yorkshire.

* It appears, from the evidence of the witnesses, that the great drawback of the west of England has been its state of comparative isolation. Its rich soil avails it little so long as the agriculturists have not an opportunity of easily exchanging their produce for the coals and manufactures they require. It is true that Bristol and the ports on the western coast are the natural ports of a large rich manufacturing district, but it never has had the advantage of a direct river or canal communication, and the railroad system has in effect deprived it of the commerce of many important districts, of which, previous to the improvements in locomotion, it was the natural metropolis. The break of Gauge raises up a new barrier to the flow of inland commerce toward Bristol.—*See Mr. Bass's evidence.*

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Manchester; it is the port for Leeds, and the West Riding of Yorkshire: even if there were one uniform Gauge throughout the country, it is a point where a transference of goods from one kind of conveyance to another must inevitably take place. Then, again, supposing the Great Western to be on the Narrow Gauge, the coals would go to Oxford, and probably would go further up into the country, and beat the Leicestershire —they might; but still if the Great Western were converted into the Narrow Gauge line, I believe the coals would still meet at or about Oxford.

210. The corn would go on to Rugby, would it not?

Clearly; the coals would make a stop at Oxford. Then, if you look forward to Southampton as the port, it would then only require, supposing the Narrow Gauge carried down to Oxford, a line from Oxford over to the South Western, to complete the establishment of the Narrow Gauge system over the whole kingdom, as far as Southampton is concerned; and, if Southampton is to become a port like Bristol, you would do away with all the inconvenience of trans-shipment, by the formation of a few miles of additional railway.

Narrow Gauge from Oxford to Southampton essential to the interests of that port.

213. Can you form any idea of the loss of time to passengers in transferring a train at Rugby to go to Oxford upon the Broad Gauge?

It would depend a good deal upon the amount of passenger traffic. Of course, if there were only a few it would require only a short time to remove their luggage, but we must not confine it in contemplation to Rugby alone, but ought to look to the changes that might hereafter take place. It is a point of small traffic of passengers; it may be a large one of coals and corn. The effect of extending the Wide Gauge into that district must inevitably lead to a multiplication of points of junction of the two Gauges, and therefore you multiply the chances of those interruptions, and you are sure to find in some places a meeting of the Gauges where the thoroughfare is a very large one, and where it is so, the

The multiplication of the points of junc- of the two gauges multiplies the chances of interruption where the thoroughfare is large.

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inconvenience is as great, as if in going to Birmingham you were told that you must not run your trains through to Birmingham, that you must change them all at Wolverton; it would be intolerable. I dare say that, even with the best arrangements that could be made, passenger trains could not be changed in less than half an hour—there would be gentlemen's carriages to change.

214. Did you ever happen to have travelled upon the Belgian railways, and to have seen the arrival of two or three trains at Malines?

Interruption on Belgian railroads.

I have experienced the inconvenience several times of having to change our carriages, and to scramble about for luggage in the most unceremonious way.

215. Involving what loss of time do you think?

I am speaking from memory,—I was detained certainly the last time I was there about half an hour.

216. Would any considerable addition to the station at Rugby be required if a change of Gauge took place there?

Break of Gauge at Rugby would require another new station as large as the present.

An entirely new station must be made; it would require to be as large as the present Rugby station. I have attended to that a good deal, and I believe a mixture of the Gauges in the stations would be impracticable. I do not mean to say that you could not draw a good plan upon paper that might appear reasonable; but I believe, in working, the most economical plan would be to have two stations.

217. Would there be great inconvenience, not only to the passenger traffic, but to agricultural traffic and to mineral traffic, wherever the change took place?

Inconvenience of transferring cattle at break of Gauge.

As to the agricultural traffic, I am quite sure there would be the greatest inconvenience; for instance, the change of beasts from one carriage to another. I do not believe you could do it at all until the beasts had been to graze again. It is done occasionally, but there is great

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difficulty in changing beasts from one carriage to another. You almost have to carry them in after they have once got out of the railway waggon, they will not look near it again until their temper gets settled down by being allowed to graze.

218. Suppose an importation of Irish pigs at Bristol, and they had to be transferred to the Yorkshire lines?

Pigs would require to be moved in loose bodies.

I am afraid it would be quite necessary to have them in loose bodies. I do not think you could manage them otherwise.

219. You could not at Worcester or at Gloucester transfer them without great loss of time?

You must lift them *en masse*.

224. With respect to mineral traffic, have you any experience of mineral districts to enable you to judge whether the proprietors of coals and other minerals would prefer the Narrow or the Broad Gauge for their traffic?

From personal experience as a miner, knows the Narrow Gauge waggons to be best for mineral traffic.

For mineral traffic, I mean as a miner, knowing all the manipulations about the pit's mouth, and I know that the Narrow Gauge waggons are infinitely superior, and more convenient for that traffic, especially for coal traffic. And I would observe, in passing, that if the Mixed Gauge system is allowed to extend in this country, the charge upon coal will, in many cases, amount to a prohibition. I mean, that it will charge the coal with a much larger toll. If we suppose the amount of capital to have an influence upon the tolls, which it must, either directly or indirectly, it is all very well to say that the Company has a maximum toll, and cannot exceed it—a penny a ton; but they may lower it. Very few Railway Companies do charge their maximum rates, showing that Companies rather tend to lower, and to consider what they can carry at so as to get a decent profit. But in the case of the

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Mixed Gauge, I pointed out very prominently the consequences of laying down a Double Gauge from Oxford to Rugby. At 4000*l.* a mile, it would be 200,000*l.*; the interest of that is 10,000*l.* a year. That would carry 60,000 tons of coals over the whole distance for nothing, instead of a penny a ton per mile. Therefore, whichever way you look at it, it comes to a commercial question at last. You must have interest for your money; and if the Railway Company were not compelled to lay down that additional Gauge, they would still be able to pay the proprietors a certain per centage, and carry the 60,000 tons of coals for nothing. Hence it is, that when you are carrying either minerals or such descriptions of merchandize as corn, that will not allow of high charges being made, you must consider the expense of the line.

Expense of laying down a double Gauge from Oxford to Rugby, would carry 60,000 tons of coal for nothing all the way.

751. I wish to call the attention of the Commissioners to a peculiarity in the district occupied by the Great Western line. Wherever you go in that district, people are flowing towards Bristol or towards London; there is little or no transverse traffic. There is not a single canal that goes at right angles to the Great Western but the Oxford Canal, which is for the purpose of bringing the produce of Lancashire and Yorkshire to Oxford. Now, if we pass along the London and Birmingham lines, what do we find there? We find that it intersects nearly all the great existing canal communications in the kingdom, and that traffic flows to it at right angles in almost every direction, which is not the case with the Great Western.

No traffic intersects the Great Western line at right angles.

There is the manufacturing district of Leicestershire and Warwickshire. The wool and other imports find their way from Bristol to the manufacturing districts, and the exports from the manufacturing districts go across to Birmingham, and find an outlet to Bristol, but there is no such communication across the Great Western. That is a peculiarity which, I think, bears very much upon the question of the district which ought to be occupied by the two Gauges. The existing canals ought to be looked upon as a fair index of the direction of the traffic, because they have been created

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by necessity, and are only now being supplanted by a superior mode of communication.

Which Gauge best.

As an engine-builder, at one time desired 3 or 4 inches Gauge.

38. As an engine builder, at one time when I was called upon to construct engines of greater power than we commenced the line with, I felt some inconvenience in arranging the machinery properly. We were a little confined in space and at that time an increase of 3 or 4 inches would have assisted us materially, and to that extent at one time I thought an addition of Gauge to 5 feet would have been desirable, but on no other account, looking at it as a mere engine builder. Since that time the improved arrangements in the mechanism of locomotive engines have rendered even that increase altogether unnecessary.

Improvements since rendered increase unnecessary.

54. In the line from London to Brighton, you of course had it not in contemplation to form a junction with any of the northern lines, when you fixed the Gauge?

Narrow Gauge selected on Brighton railway for safety and economy.

Certainly not. I felt that 4 feet 8½ inches were fully adequate for any purpose to which a railway could be applied; and believing also that the narrower the Gauge, the less was the resistance, I conceived that it would prove safe and economical.

67. When the Northern and Eastern reduced its Gauge from 5 feet to 4 feet 8½ inches, all the boilers remained the same, the wheels merely were changed.

Was consulted on railways from Antwerp to Brussels, and from Liege to Ostend. Selected Narrow Gauge.

91. The Foreign Railways with which I have been connected are as follows:—My father and I were consulted as to the details of the line from Antwerp to Brussels and from Liege to Ostend. There of course a new field was opened to us, and it would have been competent to have introduced a wider Gauge, or a narrower one, just as our experience might dictate, but we had no reason whatever to urge upon them an alteration from that Gauge which had already been established in this country, and which seemed to answer every purpose.

From Leghorn to Pisa: Selected Narrow Gauge.

The other line was the Leghorn and Pisa; there again it was quite competent to us to alter the Gauge had it

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been deemed necessary. They were the first two lines in those countries, and there was nothing to induce the adoption of the Narrow Gauge, except that it had been found in this country to answer the purpose. Perhaps if I had been called upon to do so, it would be difficult to give a good reason for the adoption of an odd measure 4 feet 8½ inches, but as an inch or two more or less would have involved a different construction of engines on a new model or pattern, I followed it, if there had been a good reason for making the Gauge 5 feet I should have done it. The Belgian railways I was consulted upon in 1835 or 1836, and the Leghorn and Pisa was commenced about two years ago, after I had, of course, seen both the Wide and Narrow Gauges in operation in this country. The Leghorn and Florence Line is about sixty-two miles long, twelve of which are now in operation from Leghorn to Pisa.

American railways on Narrow Gauge.

I know America, but I have not been there since the Railway system has extended. I know that the Gauge of American railways is the same as our own 4 feet 8½ inches. At one time they commenced laying down a line with a Gauge of 6 feet, for which the engines eventually used on the Great Western were intended; and after they had laid some considerable distance they abandoned it, and went back to the old Gauge of 4 feet 8½ inches.

Railway from Basle to Strasburg on 6 feet 3 inches Gauge. Projectors regret it.

There is a line from Basle to Strasburg with a Gauge of six feet three inches. It was made at the recommendation of some engine builder in this country; but I have had recent communication with these parties, and they deeply regret it. They say that they have got no advantage from it whatever; and they look forward to a transfer at Strasburg at one end, and at Basle at the other. I know officially that they deeply regret that alteration. The length of the line is about 60 miles.

Line from Ghent to Antwerp on a 3 feet 9 inches Gauge.

There is a line laid down from Ghent to Antwerp by M. Deroider with a Gauge of, I think, three feet nine inches. He got leave from Government, some time ago, to lay down a third rail for ten or twelve miles upon the line from Brussels, that was then being constructed toward Mons by way of experiment. He made a small engine,

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and a very beautiful little thing it was, with cylinders outside. The engine and tender were one thing—it was placed upon six wheels. The after part of the engine was devoted to coke and water, and the front part to machinery. He worked the steam high; I think eighty pounds to the inch.—He worked it very expansively. I had the satisfaction of making several journeys with that little engine; and we took a load of forty tons. We ran along that line a great distance, upwards of thirty miles an hour, with that small engine very smoothly. I believe it was a three feet six inch Gauge which he tried first; but I recommended him to increase it a little. I do not know precisely what Gauge was adopted, but I believe three feet nine inches. It is, I believe, in successful operation between Ghent and Antwerp, about 50 or 60 miles, for both passengers and goods. I have not seen that piece; but the other piece which I have mentioned was laid down under the authority of Government, for the purpose of making that experiment; and upon that line I went several journeys with M. Deroider. It is laid on transverse sleepers. The rails are light—thirty-five or forty pounds—and altogether it has been constructed very economically.

Sixty miles long, for passengers and goods.

Dutch Gauge 6 feet 5½ inches, a Dutch measure.

739 The Gauge used by the railways in Holland is different from our established Gauge here—4 feet 8½ in.; I believe it to be 6 feet 5 in. It is a Dutch measure, and it runs out, I think, 6 feet 5½ in. They were constructed in 1842. The line from Amsterdam to Haarlem was opened about three years ago. We have made engines for that line. They are precisely the same as those on the Narrow Gauge; all with six wheels. The cylinders are 14 inches in diameter, and 20 inch stroke, and the boilers 12 feet long. We supplied them with some of the old kind of engine, and also some of the new. The driving wheels were 5 feet 6 in., and some 6 feet. It is essentially a level line. It is laid on longitudinal timbers, which are considered best; and where the ground is exceedingly unsound, as it is in Holland, and liable to subside from the substratum, being a mass of peat or mud, probably the line is more

easily maintained, under those circumstances, with the longitudinal bearings than with transverse sleepers. Mr. Robert Stephenson.

36. Upon the lines in the north there never was any reason for a change of Gauge on account of the want of power or velocity; that has been always attainable when we wanted it upon the Gauge of 4 feet 8½ inches. No reason for change of Gauge on northern lines for want of power.

Construction of Engines.

40. Then, with reference to the increase of power, the size of the boiler is, in point of fact, the only limit to the power, and we have increased them in length on the Narrow Gauge, because we have always made the boilers as wide as the Narrow Gauge would admit of; but we have increased the power by increasing their length both in the fire-box and in the tubes. We have obtained economy, I conceive, by lengthening the tubes, and we have obtained an increased power by increasing the size of the fire-box; in fact, the power of the engine, supposing the power to be absorbed, may be taken to be directly as the area of the fire-grate or the quantity of fuel contained in the fire-box. Necessary steam power gained by lengthening boiler and fire-box.

41. Is there any practical inconvenience resulting from the increased length of your engines?

None whatever to the extent we have gone now. I conceive the steadiness of the engines to be very much increased by increasing the length — for the unevenness of the road is met by that; by increasing the length of the base you increase thereby the steadiness. Our present engines are made 12 feet between the front axle and the hind axle; therefore the engine may be regarded as a rectangle of 4 feet 8½ one way by 12 the other; it would indeed be 5 feet, because it would be the centre of the rail in fact by 12. No inconvenience from length of boiler. Description of engine used at present.

42. The 12 feet engine is of very late construction?

Yes, it is; they have ranged from 10 to 11 feet; we are now making them 12 feet.

43. Do you consider that the long engines are less liable to get off the rails than the shorter ones?

I consider as you increase the length, that is, the

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distance between the fore and hind axle, they are less liable to get off the rails in consequence of moving more steadily than the short engines on four wheels, where the base is the same by about 7, 8, and 9 feet; originally they were about 7 and 7 feet 6 inches, and 8 feet. The large weight hanging over the axle behind was exceedingly liable to make the engine oscillate with great violence whenever it came to an inequality.

Long engine less liable to get off the rails.

Curves.

47. Are you of opinion that the long engines you are now speaking of are more likely to get off the rails at curves than the short engines?

Not if they are kept within 12 feet. I think it possible, by increasing it beyond that very much, there would be some little difficulty in going into sidings and round sharp curves.

Resistance in curves affected by width of Gauge.

56. I believe the resistance in passing round curves to be materially affected by the width of Gauge. We know that in the collieries about Newcastle, where the 4 feet 8½ in. Gauge prevails, whenever they come to any mining operation where the power to be used is that of a horse or man, they immediately reduce their Gauge, because they want to go out and in amongst the mines with very sharp curves, and the Wide Gauge would be quite impracticable amongst those; in fact, the small carriages that are used in the mining operations are upon a Gauge of about 20 inches, and they go round curves under the ground of about 10 or 12 feet radius; they could only work such mines by such a Gauge.

Example from Newcastle collieries.

Sliding of wheels occasioned by sharp curve.

57. In the case of every Gauge, when you come to a sharp curve, you see the outside of the inside rail quite brightened by the sliding motion, because the one set of wheels has to slide forward to keep pace with the other, and the others have to slide backward; in fact, when going round a curve, both operations have to take place—the sliding backward of the one set, and the sliding forward of the other. Of course, as you increase the width of the Gauge, the difference

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between the two becomes augmented; and I think the increase of resistance, in a case of that kind, would be as the square of the Gauge, because the increased space that you have to slide over is as the width of Gauge, and you have to accomplish that in the same time as on the Narrow Gauge; therefore it is in my opinion increased as the square.

58. Are there other reasons for reducing the Gauge in the collieries besides that which you have mentioned?

Small waggon convenient for one man to move.

It is convenient for the carriages; as soon as ever the carriage is to be handled by a man, of course it must be reduced to a size that enables him to handle it conveniently.

71. The engines (of the Eastern Counties Railway before the reduction of the Gauge to 4 feet 8½ inches) were specially built for the 5 feet Gauge, but they had not availed themselves of the 3 inches of additional width; and they were of the same size of boilers as those for the 4 feet 8½ inches, so that, in that case, we go no increased power by that particular Gauge of 5 feet.

107. You speak of the 10 feet wheels used on the Great Western Railway?

They commenced some with 10 feet wheels, and 7, 8, and 9 feet wheels, there was one of 10 feet, I know. I adopted the 7 feet wheel in making some engines for them.

108. When you desired formerly to increase the engine, was it for the more convenient arrangement of the crank work, or for the more convenient arrangement of the tubes in the boiler?

It was for the more convenient arrangement of the crank work entirely; it had no reference to the boiler whatever.

162. Those engines weigh from 22 to 23 tons; I believe the same weight as the Great Western engines. I believe we have now as great a weight upon six wheels upon the Narrow Gauge as ought to be put upon six wheels; and that will be, in my opinion, hereafter the limit of power, not the width of Gauge.

Mr. Robert Stephenson.

165. Are you of opinion that, upon the Great Western line, you can carry heavier engines without injury to the road, than you can upon a Narrow Gauge line?

Construction of Roads and Engines.

No; I think the Narrow Gauge lines are best calculated for carrying weight, because in the one case you add to the rigidity of the rail itself, but in the other case, with a longitudinal bearing, you do not appear to add to the rigidity in the rail, but you get a greater portion of that rigidity in timber. Now, the timber and the rail you never can make agree, and there will always be some motion produced.

166. Does the expansion and contraction of the iron tend in any degree to disturb the action of the sleepers?

I have seen it disturb them. We endeavour to have a space between the ends of the rails, so as to avoid that. It becomes a very serious thing if they are laid close. The other day, on the Peterborough line, the rails had been laid down for three or four miles in that manner; they had been laid close. On the day of the opening it came out a bright and rather a hot day; the engine man saw the rails before him out of order; there was an arch made of three feet high and about 50 feet long, in consequence of the expansion, which raised the sleepers up into the air three feet high.

Heat of sun raised rails to an arch 3 feet high and 50 feet long.

167. Are you of opinion that locomotives could be manufactured for the Narrow Gauge capable of attaining as high velocities as the engines are now attaining upon the Broad Gauge lines?

I have no question about it. Every day we are running upwards of 50 miles an hour with our passenger trains, and those engines were not made with a view of attaining a maximum speed, but such a speed as we deemed them advisable to attain. We had never aimed to get our passenger trains upon the Narrow Gauge lines to run more than 30 miles an hour, including stoppages; therefore we had rarely if ever attempted a wheel larger than five feet six inches diameter. On

Thinks with high wheels can run as fast as on Great Western.

Mr. Robert Stephenson.

the North Midland I tried some of six feet in diameter, and they are there constantly running 50 miles an hour.

168. They still exist upon that line?

Yes; but those engines are not by any means so powerful as they may be made, nor, consequently, so swift. There is no difficulty whatever in making an engine upon the Narrow Gauge to take 40 tons at 60 miles an hour; not the least difficulty, or even more than that. I believe that the highest speed that I have heard mentioned was mentioned by Mr. Locke to me, but that was an engine by itself; it ran 68 miles an hour on the Grand Junction. Those engines on the Great Western were made for the purpose of getting great speed. Mr. Brunel thought that the Wide Gauge would admit of getting greater speed, and he therefore made all his arrangements with a view of getting greater speed than was attained upon the Narrow Gauge lines; but he never till recently, perhaps upon the competition arising, attained a greater speed than was attained upon the Narrow Gauge; because the average speed upon the Great Western was precisely the same within a shade, I believe a little under, that of the Northern and Eastern; recently, since they have adopted the plan of express trains, they have exceeded the average on other lines, because they had on the Great Western, engines prepared for those speeds.

An engine on the Grand Junction ran 68 miles an hour.

169. Is it not the fact, that the average speed on the Great Western is greater than the average speed on the London and Birmingham?

It was greater than on the London and Birmingham, not greater for the mail-train. I believe the mail-trains were precisely alike, but they were considerably below the average speed of the Northern and Eastern.

170. Have you worked your express trains with as much economy of coal, &c., as the express trains of the Great Western, do you imagine?

I think precisely the same; I see no ground for difference of consumption.

Mr. Robert Stephenson.

171. Can you state the present cost of your express engines?

The express engines on the Birmingham are smaller than others; they only weigh 12 or 13 tons, and they cost about 1,300*l.*, but they are a smaller class of engines than I should recommend. I should recommend engines weighing 17 or 18 tons, and they would cost about 1,650*l.*

173. As a public officer, having the public safety in some degree under your care, should you feel that you were taking a heavy responsibility in sanctioning the bodies of the carriages being made separate from the under frame of the carriage?

I feel it so much that I would never incur that responsibility. In addition to the objection which I formerly called your attention to, that is, the weakening of both, I consider that the under frame, when not attached firmly to the body, is more liable to derangement.

235. Are you not of opinion that an amount of work can be done with one powerful engine with the Broad Gauge system that could not be done by one powerful engine with the Narrow Gauge system?

Broad Gauge engines not more powerful, but heavier in proportion.

No; there is no difference, as far as my experience goes; it rather tells the other way at present. The Wide Gauge engines are not more powerful, but they are heavier in proportion to their power. It is quite clear that everything in the width of the engine, everything that is to go across from side to side, is giving the engine no power at all; it is an encumbrance rather than otherwise.

237. Are not the driving wheels of the Broad Gauge engines generally of greater diameter than those of the Narrow Gauge?

Not generally. I think the 6 feet wheels are used now very commonly indeed, and they have 7 feet

wheels upon some of their engines upon the Great Western Railway, what proportion I do not know. I made them 7 feet, I think, first, and I know they have a great number now of 7 feet. Mr. Robert Stephenson.

238. Has not the greater diameter of the driving-wheel a tendency to reduce the amount of the axle friction? Mechanical convenience examined.

It has certainly, but the amount of axle friction forms so small an amount of the gross resistance, that it is not worth while to measure it; I mean as comparing 6 and 7 feet; and then, again, I hold that the journals upon the Wide Gauge engines require to be larger to get the same strength, therefore you have actually lost what you mean to gain.

239. When you say that it tends to reduce axle friction, you mean on the supposition that the journals are the same size?

Yes; but if by increasing the width of the Gauge you require the axle to be increased in size, you just lose on the one hand what you gain on the other.

98. With your personal knowledge of the Great Western Railway, and your still greater experience of railways on the Narrow Gauge, do you imagine that the Great Western has, by reason of its Gauge, any advantage over the railways laid down on the Narrow Gauge? Economy of Gauge.

I am not aware of any advantage that it has. It has, I think, several disadvantages. The first, of course, is the additional expense of construction. It requires embankments and cuttings 4 feet wider, in consequence of the Gauge, in order to give drainage to the railway, than the Narrow Gauge; the one being taken in round numbers to be 5 feet, and the other 7 feet. Their tunnels are of course, necessarily increased beyond what is necessary for the Narrow Gauge. The Narrow Gauge tunnels are 24 feet wide, Disadvantages of Broad Gauge. Additional expense of construction.

... between the rails and 4 feet between ... the wall of the tunnel, that makes 24 ... to give the same space between ... the same space between the outside rail ... requires the Wide Gauge tunnel to be ... wider. The distance between the rails on the ... Western is precisely the same, I believe, as on ... and Birmingham,—6 feet.

... feet from the rail to the wall of the tunnel ... other side?

... is rather less. The tunnels are, I understand from Mr. Gooch, 30 feet wide on the Great Western. Of course the additional width increases the ... of ballasting, and of the construction of the ... This is by no means an unimportant item of ... expense.

... That applies to bridges and viaducts?

... applies to viaducts, and of course to bridges under ... railway, and also over, to give the same clearance. The expense of viaducts will be, of course, almost as much ... their width. It would not be so with some ... because there the wing-walls would be the ... In the other case; but in a high viaduct like that ... Wharncliff and Hanwell, the expense must be in ... the width. In such a case as the Blackwall ... distance, or the Greenwich, it would be as ... as well.

... there any other disadvantages of the Broad ... which you are aware of, as compared with ... Western?

... increases the expense of the carrying department ... engines are more expensive, so are the ... workshops, from their size, are also more ... engines also require greater room. I ... the curves are of a larger radius than those ... Broad Gauge, in order to allow the engine ... through without grinding the rails, or sliding

upon them; in fact, everything is upon an increased scale. Mr. Robert Stephenson.

102. Their turn-tables are more expensive?

The turn-tables are so cumbrous that they cannot use them, which I think is one great defect of the Wide Gauge; they are so large and so expensive, and occupy so much room, that they are obliged to adopt the sliding-frame system, which, I think, has arisen from the adoption of the Wide Gauge. The small turn-table for the 4 feet 8½ Gauge comes in conveniently; the carriages are easily moved upon it, and it saves a great deal of space, and the rails in the station are never broken with the turn-table system of stations; but on the other system of the sliding-frame, of course the rails are broken, except those that the sliding-frame may be opposite to. Turn tables expensive and cumbrous.

103. Do not you think that economy of working is produced by the larger engines and wider carriages of the Great Western? Economy of working.

I do not think so. I think the wear and tear of the carriages is as much. I have heard it urged indeed by Mr. Gooch, the superintendent of the locomotive power on the Great Western. I have heard it given in evidence before the committee on the Wolverhampton lines as compared with two or three other lines, and even there the difference of expense was so trifling that it was less than the difference which exists between a great many of the Narrow Gauge lines, so that it might be accidental. I see no good reason why the expense of working should be less. There are several items which in my opinion tend to make it more. I believe the resistance of the wide carriages moving along the line of the Broad Gauge to be more than upon the Narrow Gauge. Thinks the large engines and wide carriages less economical.

104. There is more friction to be overcome?

Yes, I believe the flanges if allowed to play upon the rail, would be more severe upon the Wide than

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upon the Narrow Gauge; there is additional resistance, also, I believe, owing to the wider carriages.

105. But is not that in proportion to the number of passengers carried?

Yes; the resistance would be much about the same as far as the wide carriages go. I am now speaking of the friction of the wheels upon the rail.

106. You spoke of the increased expense of the carrying department; do you mean the increased expense of haulage per mile?

No; I mean the fixed establishment of engines on the Great Western Railway: perhaps that was not a fair case to put, because their original establishment of engines has been thrown away almost entirely, for the first engines that were made were afterwards abandoned.

Express trains as economical on Narrow Gauge as on Broad.

170. Have you worked your express trains with as much economy of coal, &c., as the express trains of the Great Western, do you imagine?

I think precisely the same: I see no grounds for difference of consumption.

220. Are you at all aware what is the average weight of the useful load in merchandize waggons and the weight of the waggons themselves upon the Narrow Gauge?

Narrow waggons weigh 2 to 3 tons, carry 5 to 6 tons.

They vary from 2 tons 10 cwt. to 3 tons; some recent large ones run as far as 3 tons 10 cwt., and they will carry 5 and 6 tons of goods. I think the latter is as near two to one as possible; that is, that if the dead weight is one, the useful weight is two.

221. That applies to coals and all mineral traffic?

Yes, it is a very fair average to take.

222. Do you happen to know how that bears with regard to the Broad Gauge line?

There is not much difference; but it is against the

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Broad Gauge what there is. But it is not a mere question of dead weight, of an empty waggon and one fully laden, because the trucks are seldom fully laden. All the intermediate traffic of any country is carried on by trucks, sometimes not having half a ton in them. I do not suppose there is a single truck upon the London and Birmingham Railway or the Grand Junction Railway for intermediate traffic that has an average of more than a ton in it; and, therefore, all the intermediate traffic would be carried on by trucks weighing five tons upon the Great Western Railway with one ton of goods in them.

Intermediate traffic carried on by trucks sometimes not having half a ton in them.

232. Will you also be so good as to state what you consider would be the difference in the cost of working, first assuming the line to have abundant traffic; secondly, on a line of less amount of traffic?

I will do so. There would have been a great difference as to the cost of construction; as to the cost of working, I am not prepared to say that there is any difference at all.

233. Whether there is much traffic or little?

Either way it is merely a question of expenditure of power, and that I believe to be the same in both cases.

234. The most powerful engine is the cheapest to work with a proportionate load?

Clearly, but each Gauge may have engines of the same power.

248. Do you think it is an indispensable part of the Broad Gauge system to use the longitudinal bearings?

I think not; it is a question of expense. As you increase the width of the Gauge of course, on the longitudinal system, it leaves the expense the same; whereas if you adhere to the transverse system, you

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increase the size, and of course you increase the expense more rapidly; therefore I should say that the transverse system with a very Wide Gauge, would be very objectionable on account of its expense; but I think the principle of construction would be better.

Comparative cost of two Gauges.

736. Supposing the London and Birmingham had been made upon the Broad Gauge, have you any idea what would have been the increase of expense as compared with what it did cost?

Cost of enlarging London and Birmingham to Broad Gauge.

Of course, it is a broad question, and can only be answered approximately. I have considered the matter well over, with reference to the London and Birmingham tunnels, which would, of course, form one of the most important items of difference; and also, how much it would add to each bridge, widening them 4 feet—that is, under the railway—the increased width of cuttings and the increased width of the embankments. I have endeavoured to come to an approximation that is pretty nearly correct, and I estimate that the cost would have been about 3000*l.* a mile more than the Birmingham Railway cost, and that is without taking into consideration the additional cost of the central station at Wolverton, which would have required to be much larger than it is now.

I consider it would cost about 15*l.* a yard for tunnelling, taking good ground and bad. To make the Kilsby tunnel as large as the Great Western tunnels it would have cost a great deal more than that. On the other hand, in increasing the size of the tunnel in good ground, such as chalk, the additional cost would not have been so much. I have given, as nearly as I can, an average. The next question was with reference to the alteration of the Gauge, by increasing the width of the Gauge of the existing lines. It is practically impossible, as will be obvious from a very littly consideration. With respect to widening a tunnel, it is an operation that could not be carried on whilst the traffic was passing, and therefore, on all the Narrow Gauge lines, wherever any tunnels exist, which are

very numerous, it would involve the formation of new and separate tunnels, making use of the existing tunnels for one line probably, and afterwards making a new tunnel for the other line. But certainly, on the London and Birmingham, if any attempt were made to widen the embankments, to lay down a Wide Gauge, and to widen the bridges, I believe it would involve an absolute stoppage of the line for at least two years. I do not think it could be done in that time, and therefore the answer to the question is simply, in my mind, that it is practically impossible.

Mr. Robert Stephenson.

NICHOLAS WOOD, Engineer of Newcastle and Carlisle Railway, Director of several Railways, Coal Proprietor and Colliers' Viewer, of great experience, Author of "Wood on Railways," (selected by the Shareholders in conjunction with Mr. Hawkshaw, to examine and report on the Broad Gauge in 1838.)

Break of Gauge.

6989. Will you be so good as to favour us with any observations which may occur to you upon the whole subject under consideration, in such order as may seem fit to yourself?

I will take the order of the printed queries issued by the Commissioners and go through them seriatim. The first is the delay which the trans-shipment, arising from the change of Gauge, would occasion to the express trains. The observations which I should make upon that, would perhaps apply to both express trains and passenger trains generally. They are placed in the queries under two heads. I consider that, as regards express trains, there would be very great inconvenience, which is very appreciable in changing passengers from one carriage to another. So far as regards passengers, they would have to be taken out of one carriage and put into another, and the whole of their luggage would have to be replaced. Most people have had that to do upon different lines, and it is so annoying that I think it ought to be avoided if possible. With regard to private carriages, I think it would be a very serious inconvenience. It would be impossible to have bodies containing private carriages that could be transferred from one

Trans-shipment of express trains a serious inconvenience.

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Gauge to the other, therefore private carriages would have to be taken off one Gauge and put upon the other, and the railway carriages having to be sent through different turn rails at the station, it would occupy a considerable time. With regard to horses, gentlemen require them to be conveyed in the same train as themselves; they do not like their horses to be separated and put in other trains, and it would be a very great inconvenience and delay in passenger trains, taking the horses out of one box and putting them into another. It is extremely difficult, when horses are removed out of one box, to induce them to go into another; it is necessary to keep them quiet for some time to cool them, and it would therefore be productive of great delay. Then again, as it is difficult to say what number of carriages will come in a train, you will have to provide at the stations a sufficient establishment to accommodate the maximum number. The establishment also must be such as that you might do it in the least possible time. That I think would entail a permanent additional expense in the transfer of passengers and luggage, and carriages, and other things from one train to another. I think these are some of the principal objections which apply to this point, and that there ought to be very strong reasons for adopting a change from one Gauge to another. We see the very great expense that railway companies go to in connecting the different lines in towns, in order to prevent a change of carriages, and a change of luggage, certainly the transfer from one Gauge to another would not be to so great an extent as having to be put into omnibuses, or walk from one station to another, still, to a certain extent, the inconvenience is the same.

Difficulty with private carriages and luggage.

6092. With respect to merchandize, have you any observations to make?

With respect to merchandize, I shall first consider as having to be transferred from one carriage to an-

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other, not that loose bodies are to be used, that will be the subject of other observations, which I will presently make. The goods trains consist of 30 or 40 trucks. I think the transfer of goods from one truck to another would occupy very considerable time. I should say that the ordinary establishment could not transfer a load of goods in less than five or six hours. Then there is an objection to having goods turned over and tossed about and mixed, besides the expense. The expense is very considerable, and with regard to goods that are now carried at a very low rate, something like a penny a ton per mile, it would be the means of preventing these goods from being carried by railway.

Break of Gauge would prevent carriage of goods now carried at 1*d.* per ton per mile.

6093. But then the whole subject of railways comprises extensions into every district, branches carried into places of not very great traffic would be subjected either to laying the Broad Gauge down into them, which I think would be a great expense, or they would be subjected to a transfer of the carriages or goods. I think the system of loose boxes generally could not be carried out,—but that will come under the fifth head of the queries; I have spoken with regard to merchandize and minerals, as to the expense of removing them from one waggon to another. Minerals, if trans-shipped from one Gauge to another, would also be broken, coal, for instance, would be broken very much, and that would be a very serious objection to coals being trans-shipped. We use every means that we can to avoid trans-shipment; every transfer from one waggon to another produces a certain quantity of small coal that is sold at a much lower rate in the market than the other coal; for instance, in London the small coal is sold for somewhere about 8*s.* per ton, while the large coal is selling for about 20*s.* Therefore, besides the labour, there is a very great loss in the destruction of the article. That would apply to coals. Then again in large mineral trains, consisting of 40 or 50 waggons of coal, it would take very long time and a

Minerals broken and deteriorated.

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Expense of extra stock.

great deal of space to empty one into the other. You must have spare waggons standing constantly ready for any trains that may come up, and the number of waggons that would be required would, I think, add very considerably to the expense, besides the direct labour. We do occasionally transfer coals from one waggon to another, from the very Narrow Gauge to the Wider Gauge under ground, but we find that the breakage is so considerable that it is more advisable to run the small carriages upon the large ones than to empty the coals out, the loss by breakage is so great.

6101. So that you are adopting one of the systems proposed by Mr. Brunel for carrying Narrow Gauge loads?

Timber inconvenient to transfer, also grain and sheep.

Yes. Then again, confining myself to the transfer of goods from one carriage or truck to another, with respect to agricultural traffic, timber would be exceedingly inconvenient to transfer from one carriage to another. Timber is generally conveyed at a very low rate of charge. The transfer from one carriage to the other would add very considerably to the expense; it would have to be taken out from one truck to the other, which would be extremely inconvenient and expensive. With respect to grain and sheep also, which would have to be put from one box to another, it would require a very great deal of time at the station, and it would require a large quantity of spare carriages, and it would be extremely inconvenient to do it, so much so that I think, with regard to this sort of traffic, which is carried extremely low, it would be the means of driving it off the line, the cost being so great; at any rate it would very much enhance the cost of conveyance, which is not desirable, if it is possible to prevent it.

6102. It is said that cattle are very unmanageable when they are once taken off the Railway, have you witnessed that?

Yes, frequently. I am a director of the New-

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castle and Darlington Railway. We convey a very large quantity of cattle, in some instances 1200 head of cattle a week, they are extremely wild when they are turned out, they require a considerable time to get cooled down. I should say generally, that with regard to passengers, carriages, horses, cattle, minerals, and timber, they would all have to be transferred from one carriage to another, you cannot have a system of trans-shipment composed of loose boxes, all those articles would necessarily have to be transferred from one carriage or truck to another. It is practicable to have a system of loose boxes for merchandize generally with the exception of those that I have named, but with regard to that system I should state that we have in the North of England tried the system of loose boxes with reference to coals, and have not found it to answer. I have already mentioned the destruction of coals by emptying them from one waggon into another; and as the value of coal depends so much upon its being kept large, we have resorted, I believe, to every expedient in order to prevent breakage; we had at one time a system of loose boxes put upon the waggons in the pits, and sent down the railway to be afterwards put into the barges sent down the river, and then lifted by machinery and emptied into the ship.

Cattle require time to cool before re-shipment.

Remedies.

Loose boxes tried with coal in North, do not answer.

6103. Can you mention any collieries where that mode was adopted?

This was done at Washington on the river Wear. At North Hetton, too, loose boxes were used, and it was found that the inconvenience of sending those boxes, and getting them to the different collieries again was so great, that it was obliged to be abandoned. It is now done by having common waggons, and taking the coals by those waggons from the pit to the river and emptying the coals out into boxes placed in the barges; those boxes remain in the barges and are then sent down the river, and are lifted out by machinery and then put into the ship.

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There was every motive for lifting those boxes out of the barge and putting them upon loose trucks, and taking them in that way up to the colliery, the transition would be so easy, if it could be practically carried out. But to show the opinion of the people who are conversant with the trade generally upon that point, I may state that in every case where it is advisable to take coals upon narrow lines under ground, to be afterwards sent down lines of a Wider Gauge, which we find is the case very generally, the system of loose boxes has been abandoned. It is not practicable to carry the wide lines into the workings underground, and therefore we are obliged to convey the coals out by narrow lines into the main roads under ground, we use a larger description of carriage, and a Wider Gauge in the main lines under ground than we do in the workings where the coal is worked, and hence the necessity of a change of Gauge.

Loose-box system failed at North Hetton.

Wide Gauge cannot be made under ground.

6111. I do not think I can give you a more practical illustration of the inconvenience and expense of this plan than by stating that there is now no carrying of narrow carriages upon the Broad Gauge in any other way than under ground, where the peculiarity of the situation compels its use, and that, in every case where it can be avoided even at considerable cost, the practice is abandoned.

Carrying of carriages universally abandoned except under ground.

6122. Can you state what were the objections which prevented it?

The inconvenience of having loose boxes. In the first place the loose boxes to be strong enough in themselves to carry a load of coals must be of very much larger scantling than if affixed to a body, and then the difficulty of keeping loose boxes in the proper shape unless they are very strong, is very great, and the expense of putting them upon the trucks is also very considerable. Where there is a large quantity of coals, you must have a great many sidings, and a large number of frames and wheels,

Practical difficulties to use of loose boxes.

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and you must always have more than you require, to be certain that you can get all the boxes put on, then you must have an establishment of men to run them backward and forward, and all this is extremely inconvenient and expensive. My opinion decidedly is, that if it is advisable to adopt a system of railway which requires transfer from one Gauge to another, with regard to minerals they would certainly have to be emptied out from one carriage to another.

Transfer of minerals must be effected by emptying from one carriage to another.

6123. By lifting and canting them over?

Yes, by machinery lifting them and emptying them out. I think the system of loose boxes would be so inconvenient and attended with so much expense, that it would be more advisable to suffer the loss from the breakage of the coals rather than to adopt the system of loose boxes.

6124. I understand from you that loose boxes at Washington colliery and other places have been used?

Loose boxes tried and abandoned on the Wear.

Yes; on the Wear, coals were shipped in barges to be taken down from the Haiths to the harbour at Sunderland, and the breakage being considerable, a general system of loose boxes placed in the keels was adopted, having a steam-engine at Sunderland, either upon the shore, or a floating one to transfer the coals from the boxes to the ships. It was tried by some of the parties to send the boxes to the collieries, but such was the inconvenience that this was abandoned, and the breakage was submitted to rather than send loose boxes to the colliery.

Interlacing of Gauges objectionable.

6142. I feel quite convinced from my experience that the interposition of one Gauge with another would be very objectionable. I think it would be attended with inextricable confusion.

6155. Upon the Newcastle and Carlisle, from the

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number of curves on that line we found it desirable to try whether we could have one loose wheel and a fast one, with a view of lessening the wear and tear, that system was tried not precisely in the way Mr. Brunel has proposed it, but in effect practically the same.

Loose wheel tried and failed.

6156. Was it tried with the telescopic axles, or had one wheel no more than the depth of its nave?

The axle was turned very accurately, and then there was a groove cut in the axle, the nave of the wheel was bored to fix the axle, and a groove cut in it, and then a piece of steel interposed between the groove of the axle and the wheel, so that the wheel could move in and out, and not turn round the axle.

6157. Then, when you say one loose wheel, it was not loose in the direction of turning, but it slid outwards?

Telescopic wheel failed.

Exactly; it was not a loose wheel to turn round, but a loose wheel to move inwards and outwards, expanding like a telescope.

6158. So that it slid upon its axle, without revolving upon its axle?

Just so; we found that the carriages in that case were very liable to get off the road, and we had several instances where they got off the road.

Carriages got off the road.

6164. The risk or liability to run off was so fearful to contemplate, that we abandoned it at once.

6167. I have tried different plans of loose wheels, in order to counteract the friction underground where the curves are so small, but we cannot get them to remain on the rails; and we prefer to submit to the additional friction of the wheels upon the rail sliding round the curves, to having them loose and liable to get off.

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6168. There is every motive underground, with so many curves, to try loose wheels, but we cannot accomplish it.

Shifting bodies of carriages not safe.

6260. With respect to the original question of Break of Gauge, do you think it likely that the bodies of passenger carriages can ever be shifted with advantage from one truck to another—passengers and all included—as upon the French railways?

I think it is not advisable to do that. I think any accident happening would be of a very much more fatal character, in that case, than if the carriages were strong and firmly fastened together.

6271. And that operates so powerfully, that the selection of a train in which the carriages are not changed is thought a great point, by ladies more especially?

Passengers pay higher to avoid changing carriages.

Yes; we find that in the express train going right through to London, although the fare is higher, the passengers generally, and ladies in particular, prefer those trains to paying a less rate, and changing the carriages upon the road.

Comparison of the two systems.

6169. What do you consider to be the chief advantages and disadvantages comparatively of the Broad and Narrow Gauge?

The first point is with respect to safety,—that is an important question; and my attention was very particularly directed to this, in an inquiry that I made on the Great Western Railway on a former occasion. I found it necessary, in 1838, to investigate the different motions of the carriages, with the view of ascertaining what really did constitute safety upon a line of railway; and for that purpose I got some instruments made to ascertain the different motions of the carriages.

6173. I should observe, with respect to the rocking motion, that it will be seen that it is next to nothing, for the line traced by the indicator is in almost a straight line. This diagram shows the motion longitudinally or pitching; and there is more motion than the rocking. The rocking motion is caused only by variation of the rails,—the other motion is caused by the pitching of the carriage up and down; but, looking at the three diagrams, it is clear that almost the whole motion of the carriage is the oscillating horizontal motion, and not rocking nor yet pitching. I think that these diagrams indicate very important results in the question before you; because, if the principal motion of carriages be a horizontal oscillating motion, then the width of the Gauge has nothing to do with the motion of the carriages,—the motion is irrespective of the width of Gauge, and that is very important in the consideration of this subject. You may go down the Great Western Railway, and find a very smooth carriage with very little motion; or you may go down in a carriage, and find the motion very considerable. I went down the Great Western a short time ago, and I found the motion very considerable. It is quite clear, from these experiments, that the chief motion is a horizontal oscillating one. It is shown also, by these diagrams, that velocity has a great deal to do with the motion of the carriages. For instance, between the 41st and 42nd miles, with a speed of 9 or 10 miles, the oscillations vary from 13 to 17; whereas, at a velocity of 30 miles or upwards, they vary from 40 to 50. In my opinion, those experiments are conclusive as to the sort of motion of railway carriages; and I think that, at a very high rate of speed, the inability of the wheel to adapt itself to the straight line, is the cause of the motion. I think that any obstacle striking the wheel throws it from side to side, and that the greater the velocity the greater is the tendency to throw it from one side to the other, and the greater the difficulty of the cone to preserve a straight line; the motion is therefore a

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Safety.

Speed.

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continual dragging from one side to the other, at high rates of speed.

6176. Would not that motion be increased by shortening the length and increasing the width of your carriage?

Wider the Gauge the greater the serpent like motion.

I think the tendency to produce that motion is increased by increasing the width. I think that the motion is produced by the wheel striking some obstacle upon the rails, for instance, the joints. If a wheel strikes the joint, then that wheel is retarded, and the other moves on, and this produces a serpent-like motion. Now the further that the wheel is from the centre of motion, the greater effect any obstacle striking the wheel would have upon it, therefore I think the wider the Gauge the greater would be the tendency to that description of motion.

6177. What influence would the distance between the leading axle and the trailing axle have upon that motion?

I think the length of the carriage would have a tendency to check it, therefore a long and narrow carriage is the least acted upon by that motion, but a long carriage in any case is preferable to a short one as a check upon this kind of motion.

6178. As regards the question of safety generally on the different Gauges, are there any other matters which occur to you?

I think, as regards safety, the oscillating motion being that which has the greatest tendency to throw the carriages off the line, and as that oscillating motion is, as I stated, irrespective of the width of the Gauge, I think the one Gauge is just as safe as the other. Those experiments show that there is no rocking motion of any consequence, if there had been any rocking motion, of course the Broad Gauge presenting a wider base, would have been safer in

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that respect, but as there is, practically, no rocking motion, I think it is scarcely an item in the consideration. The danger evidently arises from the carriage getting into an oscillating motion, and as the one Gauge is just as liable to produce this motion of the carriages as the other; indeed, as the Wide Gauge is more liable than the other to throw the carriages from side to side, by reason of the wheels being further distant from the centre of motion, I think the carriages on the wider Gauge rather more of the two liable to jump the rail by such oscillation. I do not think it is a correct mode of estimating the comparative smoothness of two lines to take an accidental journey in the carriages on the two Gauges, because both cases ought to be precisely the same; they ought both to be on longitudinal sleepers, or both upon transverse sleepers.

Oscillation.

Comparative experiments.

6180. If the two rails are independent of each other, as the longitudinal sleepers are, the one side may be elevated when the other is not elevated, and therefore a rocking and finally an oscillating motion is produced, to which I attribute the increased motion on the Wide Gauge. I had not been upon the Narrow Gauge at so high a rate of speed as that at which I travelled upon the Great Western (I believe in that trip we went two miles in 112 seconds, which is about 64 miles an hour), but very soon after, finding that they had got a very large engine upon the Great North of England Railway, and being desirous to try the effect of a high rate of speed, I got the directors to allow me to make the experiment, and to have this engine ready and a train of carriages (the same number of carriages as there was on the Great Western when I went from Darlington to York in about 47 minutes, the distance being 45 miles). On some parts of the road we went above 60 miles an hour, and the motion was certainly very much smoother on that occasion upon the Narrow Gauge than upon the Great Western.

6183. What was your load?

Seven carriages.

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Speed.

6186. In the ordinary course of traffic, I should say it is as safe to run at practicable speeds, say 60 miles an hour, upon the one Gauge as upon the other, which, however, I think is too high a rate for convenience or continued safety.

6203. You mentioned that you considered the two Gauges equal for a speed of 45 miles an hour, do you consider them equal for a speed of 60 miles an hour?

No more danger at 60 miles an hour on Narrow Gauge than on Broad.

I think the safety is just the same. I should not apprehend more danger at 60 miles upon the Narrow Gauge than upon the Broad Gauge.

6204. But you think that this speed upon either is not desirable?

I do not think that it is expedient, or that the public feel very comfortable at those high rates of speed.

6205. It is not that you consider that when you go up to a speed of 60 miles an hour one Gauge has any particular advantage over the other?

No.

Above 60 miles an hour injudicious.

6206. I think it would not be consistent with prudence to found a system upon an imaginary rate of speed. I think that 60 miles an hour is the utmost limit that we ought to speculate upon. Above that rate of speed is beyond the limit of judicious travelling.

6208. But if any desperate man should want to run at 100 miles an hour, you would recommend him to take the Wide Gauge?

Of course; he is more likely to accomplish his object by the Wide Gauge than the Narrow.

6209. But not with greater safety? Mr. N. Wood.

Not with greater safety. I think he is as liable to break his neck on the Broad Gauge as the other. Of course the Great Western Company commenced with the view of accomplishing a higher rate of speed; that was not the object of the Narrow Gauge Companies, they set out with a more moderate rate of speed, and their engines were adapted for it, and therefore when it was found advisable on the part of the Great Western to increase the rate of speed, they were prepared for it, and the Narrow Gauge people were not. **Safety.**

6228. The rocking motion is so trifling that it is really not of any moment. We are very apt to attribute the oscillatory motion to rocking, because it brings the body into an apparent rocking sort of motion, but it is quite clear that the motion is horizontal.

6229. You mean the human body?

Yes, and people are more disposed to suppose the motion is a rocking from side to side, whereas it is only the horizontal motion.

6133. In the North there were at one time different widths of railways and different Gauges, but now parties have seen the necessity of making them all of one width. **Uniformity of Gauge.**

6135. In some cases it was found advisable to send coals from one line to another; for instance Lord Londonderry's railways, and Lord Durham's railways, were of different widths, they both went into the same districts, and it was found that in the course of conveying coals, sometimes the coals might come upon one line, and sometimes upon the other, and it was therefore found necessary to make them all of one width. Necessity of intercommunication produced uniformity in mineral railways of the north.

6151. It appears that the schemes now in agitation will bring in the west and south-west of

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England, two or three shifts of Gauge between Southampton and Plymouth?

Uniformity produced in the North by self interest.

I am quite sure that if they come to conduct any large extent of traffic upon those lines they will find that they must have one Gauge ultimately; I think the inconvenience will be found so great of different Gauges being carried into the same locality, that they will find it to their interest, as we have done in the north, to make the railway of one uniform Gauge.

Comparison of the two systems. Economy.

6199. You do not think that outside cylinders are indispensable in order to get high velocities and great power on the Narrow Gauge lines?

I think engines with outside cylinders are better engines for economy than engines with inside cylinders.

6216. I think there is a greater quantity of dead weight upon the Broad Gauge than upon the Narrow Gauge.

6217. You take the net load?

Greater dead weight on Broad Gauge than Narrow Gauge.

I think that the two engines would take the same net load at the same rate of speed. The gross load would be different, but then there is a greater weight of dead materials to be taken upon the Broad Gauge. I advance this opinion not merely upon supposition; it was one of the objects I had to ascertain in going into the inquiry on the Great Western Railway in 1838, whether the Great Western engines could take a train with the same expenditure of fuel, as the engines upon the Narrow Gauge, and the result of that inquiry was, that engines of a lower power of evaporation on the Narrow Gauge took the same load at the same rate of speed as the most powerful engines upon the Broad Gauge.

6234. Could you not reduce the dead weight of the Great Western to correspond very nearly with

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the dead weight of the Narrow Gauge lines; the carriages of the Great Western are much more heavily constructed, and unnecessarily so perhaps; you might reduce that dead weight?

I think the extra width almost compels you to have an increased section in the timber.

6236. Then you assume the position that the Narrow Gauge lines carry, in their carriages, as much weight upon four wheels as the road ought to bear?

I think so; and if it is necessary to have six wheels, six wheels can be put upon the Narrow Gauge just the same as upon the Broad, and in fact they are upon some lines.

Power and speed.

6280. You have stated that on the Broad Gauge they could, if they wished, get a fire-box as long as on the Narrow Gauge, and wider by several inches than they now have. Would not much of the power which this additional width of fire-box confers be absorbed by the greater weight of engine and tender it would necessitate?

Yes; I have stated before, that it does require a larger fire-box upon the Broad Gauge to produce the same result as a smaller fire-box upon the Narrow Gauge, and I stated, I think, that the engines on the Narrow Gauge, with less width of fire-box, would convey the same net load.

6281. I think the power of the engines at present is quite sufficient for any load that it is prudent to put upon the rails.

6282. In fact, that is the limit, in your estimation, within which the power ought to be applied, namely, what the rails ought to bear, and what the traffic of the country would require?

That is just the limit which I should assign in the

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decision of this question; not the power which you could make your engines, but what weight it is desirable to put upon the truck, and what load it is desirable to convey.

6283. And you can easily find the power to move it?

You can easily find the power, in either case, to move it.

6284. At any prudent velocity?

At any prudent velocity.

Dead Weight.

6219. The extra width in the fire-box got by the Broad Gauge is not more than equivalent to the extra resistance of the dead weight, which is greater upon the Broad Gauge than upon the Narrow. I think that the limit of speed and weight should not be that which is determined by the power of the engines, but should be that weight and speed which it is advisable to travel with upon public lines of road. That is the limit which should be assigned in judging of the two systems. I think it would not be a correct mode to go upon any imaginary case, the questions are, what weight is it advisable to take upon a truck? what number of passengers in a carriage? and what should be the load per train?

6232. I think it is more correct, in comparing the two Gauges, to set out with supposing that you get the same power of engine upon each line, there is no danger in laying down the rule that you attain a rate of speed beyond which it is not desirable to go upon either Gauge, that you have got the weight of a train of goods beyond which it is not advisable to take?

Opinion of Gauge.

6238. You are disposed to conclude that as the railway system becomes more developed, and there are a greater number of lines and a greater number of branch lines, the Narrow Gauge will be still more applicable to the traffic of the country than the Broad Gauge?

That is my opinion; I think that the question

ought to be considered with reference to branches being carried into every district. Mr. N. Wood.

6239. With reference, in fact, to the wants of the locality?

To the wants of the locality and of the country; we find that the moving about of those large trucks capable of carrying a very heavy weight, would involve an expense of establishment that it would not be advisable to entail upon the country when the system is extended into every town and village.

6240. Then, if the whole system of railways in this country were now under consideration previously to construction, you would not recommend the Broad Gauge in preference to the Narrow? Economy.

No, I should not. I think the Narrow Gauge is more adapted to economy, in a commercial point of view, than the Broad Gauge. I find that in several cases of recently constructed railways, there is a limit put to the weight that is to be conveyed, it is one of the stipulations in the rules, that the weight shall not exceed a certain amount. Narrow Gauge more adapted to economy in a commercial point of view than Broad Gauge. Limit put to weight to be carried in new railways.

6241. Is that a wise stipulation?

I think it is.

6242. Do you think it conduces to economy and safety?

I think so. I think to economy especially. Of course the Wide Gauge being constructed upon a larger scale, that limitation would be higher upon it than upon the Narrow Gauge, but I think that the limit of 5 or 6 tons upon one carriage is a judicious one. I think that the weight beyond that, commercially considered, is unwieldy and unprofitable. Five or six tons enough on one carriage.

6243. And destructive of the road?

Destructive of the road and difficult to move about.

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6244. With reference to the engines in comparing the Broad Gauge with the Narrow Gauge, have you any reason to suppose that the coke is used more economically in the production of power?

I think the construction of Narrow Gauge engines is more economical than that of the Broad Gauge.

6249. Of course there are engines of all the different kinds of construction upon both Gauges, but the question is, can you construct upon the Narrow Gauge an engine with the machinery so disposed as to be as economical as upon the other? and I think you can.

Economy of working.

6253. We have touched upon some of the questions under the last head already, but if you would favour us with your remarks upon any points which have not been mentioned yet, relating to it, we should be obliged to you?

Area of narrow truck as great as of broad.

I think I have said all that occurs to me as to the commercial advantages with respect to merchandize. I think I have commented upon the question in sufficient detail, but I should say generally, that you will find, on reference to the area of the truck which carries the goods, that in fact the Narrow Gauge truck is just as large as the Broad Gauge truck, and the limit is the weight that it is advisable should be carried; that there is no advantage whatever by having a broad base, which the Broad Gauge possesses, because we find that on the Narrow Gauge the area of the truck is just the same as on the Broad, and therefore there is no occasion to have the Broad Gauge to carry a heavier load. You can carry, if it is advisable, as heavy a load upon a Narrow Gauge truck as you can upon a Broad Gauge truck. Therefore, with respect to merchandize, it is not necessary to have the Broad

Broad truck not required for merchandize.

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Gauge for that purpose. With respect to mineral traffic, we get a weight of 6 tons of coals in a carriage. The carriages now constructed for the Great North of England and for the Eastern Counties are to carry 5 or 6 tons; 6 tons are now carried on the Great North of England. I think in mineral traffic 6 tons is quite as much as economy would point out ought to be adopted. In short branches, as I have stated before, we want a less weight, and we are now getting a little experience of the use of both in the North, because we are using for the short branches 53 cwt., and for the long distances 6 tons. I think 6 tons of coal is as much as ought to be put into any carriage, and I do not think any economy would be accomplished by using larger ones. Then, with respect to agricultural traffic—grain—you can put as many sacks of grain upon a Narrow Gauge truck as it is advisable to carry. As to timber, it is generally carried upon two or three trucks, in fact, the length renders it necessary, and therefore an extra width is unnecessary.

Thinks 6 tons of coal enough for one carriage.

Narrow truck carries ample quantity of grain.

6254. It is spread over half a dozen axle-trees?

Yes, and there is no advantage in having a wide base and a wide area for the purpose of carrying timber. With cattle again, you can put as many cattle into a pen as it is advisable to put into any pen, whether it is carried upon the Broad Gauge or upon the Narrow. I think therefore, with respect to the commercial advantages upon merchandize, minerals, and agriculture, that the quantity conveyed in a carriage is as large as it is found advisable to take upon the Narrow Gauge, and therefore a wider one is unnecessary, and being unnecessary and more expensive, is of course objectionable.

No advantage in wide base for timber.

Narrow cattle truck holds as many as advisable.

For all commercial purposes ample space on Broad Gauge.

6258. Do you think it is judicious to fix 5 feet 3, as the Irish Gauge at the present moment, or would you be disposed to recommend the Government to fix 4 feet 8½ as the Gauge, that

Mr. N. Wood.

being a country where the traffic is considerably less than in the manufacturing districts of this country, and where economy ought to be an object?

Would not increase Gauge for Ireland.

I think I would not adopt a departure from the 4 feet 8½ in that country. As I stated from the experience of improvements in the locomotive, and knowing that economy in such a place as Ireland, must be of very great moment, I am of opinion that 4 feet 8½ inches would be preferable to a wider Gauge in Ireland.

6221. So far as regards the accommodation and comfort of passengers, the one Gauge is just as comfortable as the other; with this exception, that having three passengers in width in a carriage is more comfortable than four.

Economy of construction and of working.

6231. Of course in the consideration of the question generally, the economy of construction is an item to consider. There is no doubt that the Broad Gauge is much more expensive to construct than the Narrow. Perhaps in long lines of railway that is of less consequence, but when the system is carried into every corner of the country, and when economy will become a very great object, when you are to carry lines into places possessing little traffic, the expense of construction will then become a very serious consideration, and that system which can be constructed at the least expense will be most advisable to be adopted. I think on that account the Narrow Gauge has a very great advantage.

In lines of little traffic expense of construction a serious object.

Question of dead weight.

6232. Setting out with an engine of precisely the same power upon both lines, I think that the economy will be in favour of the Narrow, because the quantity of dead weight is greater upon the Broad than upon the Narrow, and therefore the result of the cost of conveying the goods and passengers must be in favour of that Gauge which carries the least dead weight.

Mr. H. P. Bruyeres.

Aug. 15, 1845.

Mr. HENRY PRINGLE BRUYERES, late of the Royal Engineers, Superintendent of the London and Birmingham Railway.

978. From your experience of driving sheep and cattle into the vans and boxes, do you think any great difficulty would arise at the point of junction in removing them from one set of carriages, and forcing them into another? **Break of Gauge.**

From what I have seen I do not hesitate to say, that with some of the trains of cattle, consisting of 50 or 60 loads, (say 15 sheep vans and the remainder cattle waggons, containing 1,200 sheep and upwards of 200 oxen), the removal would scarcely be accomplished in a day. I have been looking on when nearly two hours have been occupied in trying to get one animal into a waggon after having taken him out. This was at the Birmingham Station; the load came from Gloucester; two animals of the six were down, and it was thought advisable to take them out before they were sent on to London; they were taken out, and it was nearly two hours before the men could get the last animal in again. Trains of cattle containing 1200 sheep and 200 oxen, would require a day to remove at break of Gauge.

979. That, however, is probably an extraordinary case—an exception to the general rule?

I name it as an extreme case, but we frequently find animals very difficult to get in; and if required to transfer them from one waggon to another the difficulty is increased; they seem to remember the journey, and evince no wish to recommence it by willingly entering another pen. We occasionally have to trans- Animals will not re-enter a waggon after a journey without delay to rest and graze.

Mr. E. P. Bruyeres.

fer cattle at Rugby; they come up, a few loads at a time, when we have not cattle trains going on, and rather than wait for the next cattle train, which may not be expected for some hours, the drivers take the animals out, and we have extreme difficulty in getting them in again; indeed, we find so much difficulty that we would rather send them on with a special engine, if there be anything like a train, than have the trouble and labour of reloading them.

Military uses of railways.

983. As superintendent of the London and Birmingham traffic, you have been present at the placing of troops of various descriptions in your trains; will you be so good as to give the Commissioners some description of the mode in which it is done, and the time it occupies?

How troops are arranged to go by railway.

At the Euston station we usually marshal the train by the platform, and the troops are formed in line on the arrival area in front of the station; when the train is ready they are divided into divisions of as many as the carriages will hold, either 24, 28, or 32, according to the number of seats. They are then marched in. The carriage in which they are to be placed is immediately opposite to the passage; and when that carriage is loaded, the train is moved to admit of the second carriage coming opposite to the same entrance, and another division of men marched in; when they are seated the same operation goes on throughout the whole. I have seen between 300 and 400 men loaded and ready to go away in about half an hour. I cannot state positively the time, but it did not much exceed half an hour from the time when the train was ready. I was present when the horse artillery went down to Manchester, with half a battalion of the Foot Guards, in August 1842. That is the only body of cavalry I I have seen loaded; with that exception, and the return of the troops some months after, cavalry have not

300 and 400 men arranged in half an hour.

Mr. H. P. Bruyeres.

been moved on the London and Birmingham since I have been connected with it. It was done in a similar method method to loading infantry. The Foot Guards were placed in the carriages on one side of the station, and the Horse Artillery on the opposite. The boxes were ready at the platform to receive the horses, and the moment the troop arrived and dismounted, the horses were put in with their bridles and harness on. Two or three boxes were loading simultaneously, and the time occupied in loading the whole troop was nearly two hours; there was great difficulty in getting some of the horses into the boxes. There were 50 or 60 horses with two guns. From the very short notice given to the Railway Company (not more than five hours) of the intended move of these troops, the Government must have deemed it very important that they should be conveyed to Manchester with the greatest possible despatch. The troops left the Euston station about ten o'clock at night in two trains, and were in Manchester before ten the following morning. Had the trains been subject to a change of Gauge on the journey, independent of the probability of not finding sufficient carriages in readiness at the junction station (upwards of 30 second class and 20 horse boxes, besides other trucks with the ammunition, &c.), a delay of several hours would have been unavoidable. Some of the troop horses were so obstinate in their nature, that if taken out of the boxes, there must have been extreme difficulty in getting them to re-enter others immediately.

At five hours' notice, half a battallion of Foot Guards and Horse Artillery were sent to Manchester between 10 P.M. and 10 A.M.

With a change of Gauge delay would have been inevitable.

987. Do you mean to say that nearly two hours were occupied with the 50 or 60 horses?

Yes; some were very troublesome to get in. The guns were put on trucks in a very few minutes. It took no more time to load them than it does to load a private carriage. The guns were put in on their wheels; they were unlimbered, and run upon the truck; the gun and the limber went on the same carriage; they fitted into one another.

50 or 60 horses took nearly two hours to ship.

Mr. H. P. Bruyeres.

990. Would it be more difficult than the removal which formerly took place at Birmingham, from the Birmingham Railway to the Grand Junction, at the time when carriages did not run through?

Plan of transfer of passengers at Birmingham.

Within my recollection they have always run through; and although the passengers get out, and go round to an opposite platform, and the carriages are turned from the line by which they arrive to another on which they depart, the luggage remains untouched; therefore the passengers have only to get out and retake their places, the smaller things remain in the interior of the carriage, and the larger description of luggage upon the top. That has been the practice for nearly six years. If a difference of Gauge and a break is to take place, I should decidedly say that it ought to be at Oxford, and not at Rugby. Rugby is the focus of several Narrow Gauge railways, and it is a place at which little is likely to be consigned to remain; whatever comes up to Rugby is principally going beyond it.

1074. In the event of troops coming up from the north, and crossing the Birmingham line at Rugby, to join the Great Western line at Rugby, the carriages in which they arrived at Rugby would take them across the line to the Great Western station; and it is assumed that the two trains would be marshalled alongside of each other, and that the soldiers would march from one Gauge across to the other in the order in which they were formed at your station upon the occasion you have described?

I doubt that the men could be transferred from one set of carriages to another without being reformed into line. We find from experience, that if the troops get out of the carriages at Birmingham, there is so much difficulty and so much time lost in getting them in again, that the commanding officers do not allow them

Officers do not allow men to leave their seats.

to leave their seats, and any refreshment the men may require is given to them in the carriages, and not out. Mr. H. P. Bruyeres.

1075. So that, in the event of a disturbance happening in the north, or being expected in the north, and troops being required from Exeter or Plymouth, a great detention would take place wherever the break of Gauge might occur?

Certainly; it would be impossible to prevent it. Do it as quickly as they might, I think there would be the loss of upwards of an hour with 400 infantry, and double the time with one troop of cavalry; and if the baggage had to attend the regiment, it would be a very much longer period. If we had had no notice, and we had to find carriages, we might, and most probably should be, deficient in carriages; it requires a large number of carriages to move a regiment. It usually takes about twenty second-class carriages for the transfer of half a regiment, with the women and children. In reference to the removal of troops, I may mention to the Commissioners that about two years ago (May 1843), at the time of the monster meetings near Dublin, the 11th Regiment of Foot was ordered from Weedon to Dublin, and the Commander-in-Chief was desirous that the regiment should be moved in one body, and in as short a time as possible. The regiment left Weedon about seven o'clock on one morning, and on the following morning they were in Dublin, having got to Liverpool, without change of carriage, between three and four o'clock on the afternoon of the day they left Weedon. The railway companies were called upon rather suddenly to send these troops, and they required second-class carriages. We had to borrow some of the carriages from the Grand Junction, in addition to what we had ourselves. The regiment required forty-four carriages; and had there been a break of Gauge at Birmingham, we should have had to find the forty-four carriages in the first instance, and the other company would have had to find a corresponding number. The loss of time in the transfer of the whole regiment, with

Break of Gauge would delay 400 infantry an hour, those of cavalry two hours, baggage much longer.

Twenty second class carriages for transfer of half a regiment.

At time of monster meetings, near Dublin, the 11th Regiment of Foot left Weedon at 7 A.M., and were in Liverpool at 4 P.M.

Had to borrow carriages from Grand Junction.

Mr. H. P. Bruyeres.

the baggage, would have been at least three or four hours; and as it was important that the move should be made rapidly, this detention might have been of consequence.

Break of Gauge at Rugby.

1050. In the event of the Gauge being broken at Rugby, do you see any inconvenience in running the Narrow Gauge waggons upon Broad Gauge trucks, conveying them on the top of the Broad Gauge trucks?

My own impression is, that to run one truck bodily on to another will be found wholly impracticable for general purposes.

1051. Suppose there was a set of empty Broad Gauge trucks in a line, and suppose a train of goods waggons of the Narrow Gauge was run upon them, would not that arrangement be convenient?

190 loads of cattle arrived at the London station in one day.

Yes; it might be, with very great delay and labour. With regard to cattle, upon one day, the 12th of July last, 190 loads of cattle arrived at the Camden station. I cannot say exactly the number of those cattle that had come from other lines, but perhaps 100 loads out of the 190 came from the Midland line, or from towards Liverpool from the Grand Junction; and if it had so happened that they had had to be sent forward on a Broad Gauge line, it would have been not only the inconvenience of unloading and reloading those animals at the Junction station, but the Company receiving them would have been obliged to have had a corresponding number of waggons ready to put them into, whereas they came to us in detachments, and all we had to find was the engine power for each train.

With a break of Gauge not only delay, but a double stock of waggons required in waiting.

With a break of Gauge the animals must have been separately transferred from one waggon to another, and there must have been a stock of waggons in waiting of each description required. As no previous notice is given of these trains, it would require an im-

Mr. H. P. Bruyeres.

mense and almost useless stock to be always kept at the Junction station. The same objection applies to the passenger traffic. In the spring of the year I have known 25 or 30 carriages of one description or another upon a passenger train, and amongst them there may have been 12 or 15 horse boxes and trucks, with the private carriages of gentlemen coming up to London. The boxes and trucks have come to us from different places. We have had no extra stock at any one particular station, whereas at a junction station, with a break of Gauge, there must be a number of each sort in readiness equal to the whole that we take off. Within half an hour another train of similar extent may arrive. Then take the great horse fairs in the north of England: we have had 105 horses up by one train from York, and had to assist the Midland Company with the loan of boxes for them. No one Company have boxes enough at their immediate disposal for this occasional traffic; but they borrow from one another. If there existed a break of Gauge, then one Company must have a stock equal to the whole.

No extra stock kept at any one station.

At horse fairs have to lend Midland's horse boxes.

1053. If a change of Gauge took place at Rugby with a view to removing the luggage and goods by means of loose boxes, would it not involve the necessity of having the whole of the Midland Counties waggons, as well as those of the North Midland, the York and North Midland, and of the Great North of England, formed with moveable boxes also?

Break at Rugby.

Clearly; because all the Narrow Gauge lines, from whence the traffic came, would be liable to the same transfer. Supposing a carrier at some distant place to load his goods in a waggon not constructed to transfer the body, on arriving at the junction where the break of Gauge existed the goods would have to be unloaded and reloaded into another waggon, a responsibility that no Railway Company would like to undertake. The carriers would therefore be compelled to have an agent

Carriers would be compelled to have an agent at each station.

Mr. H. P. Bruyeres.

and establishment at the junction, in case of this contingency arising. Oxford would be a better town for this additional establishment than Rugby. To give the Commissioners some idea of the labour and expense of transferring goods, the lowest charge the carriers make, one with another, is 1s. 6d. a ton. The Grand Junction Company charge 2s. 6d. a ton.

Cost of transfer, 1s. 6d. to 2s. 6d. a ton.

1054. What distance would that 1s. 6d. carry a ton upon your line?

Which would carry a ton of coals eighteen miles.

If they were coals, it would carry the coals eighteen miles. In point of time, I believe that if one of the trains such as daily come up from the north with from sixty to seventy waggons, could be transferred, even by the moveable box plan at Rugby, the train would not be ready to start from Rugby by the time another train, on a contiguous Narrow Gauge, would have reached Oxford.

Inconvenience of Break of Gauge to military.

We should require more time to make a transfer of troops at Rugby than at the Euston station, where we have every convenience for the purpose. I think the inconvenience in the transfer of troops would be very great: the men on getting out of the carriages mix together, and it takes some time to reform them into line; they would then have to be held off into divisions, and if the platform were not conveniently arranged, retaking their seats would occupy more time than it did at the Euston station. The transfer of the heavy baggage, which to a regiment of infantry is from thirty to forty tons, would take some considerable time.

1080. How many trains do you start from the Euston station in a day?

Besides the passenger trains which are advertised in the time bills, there are four luggage trains down and four up; we are now going to put on another, so that we shall have five luggage trains down and five up: these are independent of two or three cattle trains on two days a week,—viz. Thursdays and Saturdays.

Mr. R. Creed.

Nov. 1st, 1845.

Mr. RICHARD CREED, Secretary to the London and Birmingham Railway Company.

Opinion on Gauge.

4914. Do you know at what period of the construction of the London and Birmingham railway the question of Gauge was determined upon?

I think it was as soon as the Act had been obtained, or rather previous to the Act; it had been considered in reference to the expense of construction, and Mr. Stephenson was consulted whether it might be expedient to give a little additional width to the Gauge, and he stated that any advantage that would be derived from a partial addition of width to the Gauge above 4 feet $8\frac{1}{2}$ inches would not be compensated by the great inconvenience that would result to the traffic of the country generally from having a different Gauge. The advantage was only supposed to be a possible degree of accommodation to the engine makers in fitting particular parts of their engine.

4926. Do you remember what increase of Gauge was contemplated on the London and Birmingham Railway Company?

There was nothing specific named, but I can say this, that the Company did not contemplate going, under any circumstances, beyond 5 feet: at least, I never heard any wider Gauge named than that.

4928. Have you, as a secretary of the London and Birmingham Company, ever heard it brought forward in your official capacity, either by the

Mr. R. Creed.

directors or the officers of the Company, that the Gauge was insufficient for the objects of the Company?

Never.

4929. From your own knowledge of the working of the line and the demands of the public, both as regards passengers and goods, have you had any reason to regret the adoption of the 4 feet 8½ Gauge?

Never, as far as my experience and observation go; I should certainly not be disposed to adopt the Wide Gauge of 7 feet.

Seven feet Gauge involves expense without commensurate benefit.

5008. You state that in a fresh country you would not like to take 7 feet as the Guage. Have you any distinct objection to that Gauge, or is it merely that you are satisfied with what you have?

The objection is, that there would be an increased cost without, as far as our experience shows, any commensurate benefit. That is, in fact, the great ground of objection.

Uniformity of Gauge.

4931. I should say decidedly, that the want of uniformity of Gauge in this country is an evil. I think it would be very desirable that the larger Gauge should be adapted to the smaller if possible.

I do not think the converse of that proposition is so desirable, because in the first place, I am not a convert to the advantages of the Wide Gauge; and in the next place, the proportion of the Narrow Gauge to the Wide Gauge is as 8 to 1.

Break of Gauge

4934. You are aware of the great number of schemes that are now afloat for the purpose of extending

Mr. R. Creed

railways all over the country, and you are also aware of the many points where the Broad and Narrow Gauge would come into contact, do you, as a commercial man, think that a Break of Gauge would be attended with great inconvenience to the country, commercially speaking?

I think it would certainly cause delay and increased expense.

Convenience of Passengers.

4944. You are, I presume, disposed to think that a carriage containing 18 passengers is better than a carriage containing a larger number, 32 for instance, and looking at the necessity you are sometimes placed under of sending carriages with a small number of passengers to a distance, it would be more expensive to you to send a carriage capable of holding 32 passengers, than one containing 18 passengers?

Certainly, that is an argument in favour of the Narrow Gauge, as far as regards economy and convenience.

5021. The passengers could be passed through perfectly well. If it were the same Gauge, they could be passed through in the same carriages, whatever number of lines might meet at Rugby.

Conveyance of Merchandize.

4947. We think that our waggon is more convenient than a larger one would be, because it admits of more convenient assortment for the general wants of the traffic.

Economy of Working and Construction.

4970. Will you state in what way you estimate the work done? Do you estimate it by the number of tons conveyed, the number of passengers conveyed, or in what way?

Mr. R. Creed.

Cost of Great Western 16 per cent. more than London and Birmingham.

We take it at the cost per passenger, and the cost per ton of goods. The cost on the Great Western Railway to the number of miles run by the engines, as compared with the London and Birmingham, is as 16 per cent. more by the engines, and 16 per cent. more for the cost. It thus appears if you take 885,994, and subtract that from the return given by the Great Western Railway Company, and see what the difference of mileage is, you will find it 16 per cent. If you take on the other hand, the cost returned by the Great Western Company, and the cost returned by the London and Birmingham Company, and deduct the London and Birmingham expense for the Great Western expense, you will find that that also is 16 per cent. The relative cost is the same, however the account may be stated.

4977. Is it the case with the Great Western that the greater portion of their passenger traffic is conveyed over that portion of the line where the gradients are the worst?

I think, if you look at their returns, it will be found that the increase of mileage of passengers, since they have come into their bad gradients, bears no proportion to the mileage which they had before.

Receipts of London and Birmingham larger, expenses less.

4991. Then the Commissioners are to infer from this that the London and Birmingham locomotive expenses are smaller, while their receipts upon a not greater scale of charges are larger?

Yes.

A great deal of dead weight on Great Western Railway.

4992. Upon comparing this with the statements preceding, it would seem that there must be a great deal of dead weight in the Great Western trains?

That is precisely the inference that I draw.

Mr. R. Creed.

4989. Can you state at the present moment whether your scale of charges for goods per ton is greater than that upon the Great Western per ton per mile?

It is less considerably, but I would not say how much. I have gone through the scale for our passengers as well as for our goods, and it is below the Great Western. It must be noted that they are carriers, and we are only toll receivers.

5009. In stating the increased cost, does your remark apply principally to the earth works and the permanent way, or to the stock?

Not only to the earth works and the permanent way, but also to the engines and carriages which it is necessary to employ, and which must be all in proportion to the increased width of the Gauge.

Power and construction of engines and carriages.

4980. We have now engines on our line not so powerful as those that we shall have; but we have engines now that take 40 waggons with our heavy loads.

4982. You consider that the London and Birmingham from the way in which it has been worked hitherto, is not a fair specimen of a Narrow Gauge line?

Certainly not. We have come earlier into the increased work than we should have done if we had not been desirous of giving the public the benefit of lower prices than we previously charged.

4990. Understanding that with regard to the general scale of your charges, can you give any statement of the relative receipts and the relative

Mr. R. Creed.

Relative expenses on the Birmingham and Great Western Railway.

expenses upon the Birmingham and the Great Western Railways?

On a comparison of the statements furnished of the mileage of passengers, receipts for coach and goods traffic, and the actual expenses incurred for locomotive power on both railways in five consecutive half years ending on the 30th of June, 1845, as extracted from the accounts laid before the proprietors at their respective general meetings, I find as the result that the mileage of passengers on the Great Western Railway is 152,882,315; on the London and Birmingham Railway, 144,904,867. The Great Western mileage is more, therefore, by 7,977,448 The receipts for coach traffic on the Great Western Railway are 1,583,054*l.*; on the London and Birmingham Railway, 1,640,087*l.* On the Great Western Railway they are, therefore, less by 57,033*l.* The receipts for goods by the Great Western Company, as carriers, are 364,943*l.* On the London and Birmingham Railway, as toll receivers, 481,901*l.* On the Great Western they are less by 116,958*l.* The expense for locomotive power on the Great Western Railway is 189,305*l.*, and on the London and Birmingham Railway, 179,026*l.*; the Great Western expense, therefore, is more by 10,279*l.*

Speed.

5040. Should you find any difficulty in running at a higher rate of speed?

I think the difficulty to us, or to any other line circumstanced as ours is, would be the interference with trains of a different rate of speed, not the inability to master the speed. On every great railway that would be a very important consideration.

MR. PETER CLARKE, General Manager of the Brighton Railway Company, previously Superintendent of the Midland Railway, Traffic Manager of the York and North Midland, and, until it was leased by that Company, Traffic Manager of the Leeds and Selby.

5151. Have you at all thought of the inconvenience likely to result from a break of Gauge? **Break of Gauge.**

I found great inconvenience while I was in the North Midland Company, in the traffic we had to and from Bristol up to the opening of the Bristol line, from the detentions, loss and mis-sending of packages which arose. I attribute a great share of it to the change of Gauge at Gloucester. **Loss and mis-sending packages through Break of Gauge at Gloucester.**

5169. Can you give the course of a heavy goods train starting from Leeds; towards, generally speaking, to what places are the goods directed?

From Leeds the train starts to Normanton. We there take up goods from the Manchester line. Our next place is Bansley.

5170. At Normanton you pick up waggons?

Yes.

5171. You do not receive loads to put into a waggon?

No; we take the waggons, which may be fully or partially loaded, destined to stations along or beyond the Midland line.

5180. I think fully one half of the waggons of a heavy

Mr. P. Clarke.

goods train starting from Leeds towards the south go through without being opened, London goods being the great traffic of the manufacturing districts.

5193. You think that Bristol rather than Birmingham should be the point where the break of Gauge should take place?

Yes; heavy trains of goods will go through Birmingham, but Bristol will be a place of dispersion more than Birmingham.

Conveyance of merchandize.

5187. Supposing your waggons were so large that they carried double the weight of goods, in what way would that affect your loading and unloading?

Only London trade can give more than six tons of merchandize per load.

It would be detrimental to the trade. I think when you get about five or six tons per waggon, it becomes so large that it is only the London trade that can afford a full load. The effect of introducing large waggons upon the line would be inconvenient to the trade of small towns. The waggons which we were making when I left the Midland Railway carried six tons each, and were large enough for any purpose. That is as much as it would be desirable or almost practicable to carry in any waggon with advantage to the trade. When you get larger quantities in a waggon, the rubbing or chafing becomes much greater; the pressure upon the lower goods is greater; and upon manufactured packages, which are very tightly pressed, the chafing of them is such that very frequently damage takes place. There is a certain motion in those loads going on, and any inequality in the package, by having a large pressure upon it, with the motion, cuts through the folds of the wrapper, damaging the contents.

Large loads chafe and injure cloth.

5203. In short, you are of opinion that the larger the carriage the greater the damage?

Yes; there is a greater risk of damage by a larger bulk being put together.

Mr. John Ellis.

Nov. 6th, 1845.

Mr. JOHN ELLIS, Deputy Chairman of the Midland Railway, a Director of the London and Birmingham, and of the Leicester and Swannington.

Break of Gauge.

5768. I have not seen the expedients proposed by Mr. Brunel for shifting loads from one Gauge to the other, for I have not thought it worth while to go to look at them; but I have no doubt that Mr. Brunel will provide something as ingenious as any man can provide. I have had a good deal to do with the coal trade, and I am satisfied that the change of Gauge would be nearly a prohibition, for it would occasion such an expense that we should not be able to compete with the Staffordshire coal field, as we ought to do for the benefit of the public and ourselves too.

In the coal trade a change of Gauge a prohibition.

5772. Now take such a time as this, when we are exceedingly busy in the Leicestershire coal trade. Suppose we have sent a train to Rugby with a lot of loose boxes, and that we have removed them on to Mr. Brunel's platform, and they come back to our colliery, and we want to load them for an entirely different district; they are of no use to us for that purpose. If we happen to have no trucks but those, the coal must be stacked till we have some from somewhere else. I can see nothing but interminable trouble and cost, and inconvenience and confusion of all sorts. Then if you are to carry the Broad Gauge to the collieries, the confusion and cost are beyond all calculation. We have all the small roads to the collieries made upon the Narrow Gauge, and we have all our turn-tables upon the Narrow Gauge. We have miles of rails laid down upon some of the collieries. I sold the Clay Cross Colliery, a mile and a half of rails, the other day, from the Leicester and Swannington, to put down in addition to the present

The loose box system a failure.

All small roads to collieries made on the Narrow Gauge.

Mr. John Ellis.

If Gauge changed, all these changed too.

rails, merely for the bye-rails to the colliery; old 35 lb. rails that we have taken out as too light. If the whole thing is to be changed, all those must be swept away; all our roads must be pulled up; in fact, you cannot imagine the cost and difficulty that would arise from it.

5775. I have been for many years connected with railways; the Midland was leased to the Gloucester Railway to prevent the Broad Gauge coming to Birmingham; we had had so much trouble with it the summer before. I am in some measure connected with the worsted trade. I live at Leicester; our wool went to Manchester, and all over the country, and we could not get it. The wool merchants found that the inconvenience and delay were beyond description, in consequence of the change of Gauge at Gloucester. That was before we purchased the railway.

The break of Gauge caused loss of wool.

Loose-box System.

5793. There would be no breaking of coal, I imagine, in shifting from the Narrow to the Broad Gauge by the loose box system?

The Midland Counties tried the loose box system before I was on the Board. The Midland Counties Railway is a railway from Rugby to Derby and Nottingham. It was first projected by the Derbyshire coal-owners to fight the Leicester and Swannington Railway, which had destroyed their trade to Leicester; their way of competing with the Leicester and Swannington coal was to bring the coal down the Erewash Canal in loose boxes to the junction of the Trent, and to lift them by a crane out of the bottom of the boat on to a flat truck, which carried two of them; that went on for a year or two, during which time they had an advantage; in fact, the Railway Company charged the coal-owners with none of the expenses of the moving, which were considerable. But when the Derbyshire coal-owners were put on a fair footing by the railway, that trade entirely disappeared, and we have either converted those loose boxes into fixed waggons, or we have sold them for old iron; we sold a great part of them for old iron the other day; and the whole work stands there as a monu-

Loose boxes for coal tried on Erewash canal and failed.

The whole work a monument of folly.

Mr. John Ellis.

ment of folly to be looked at. The basins are of no use, and the warehouses are of no use; the whole thing is gone to the dogs; it is not worth sixpence a year to the Railway Company. As soon as this experiment was put into competition with other modes of conveyance it failed entirely; and in the course of twelve months after that, I think it ceased. There may be 300 tons a year come there now—certainly not more.

5796. An eminent engineer has told us that the whole cost of shifting at Rugby the entire coal trade of that part of the country would be about 1*d*. a ton?

But the question is what it would cost the coal-owners to have a new plant for the whole of the trade.

5797. They say, upon that point, that you must have a fresh plant for the Oxfordshire trade; if you have got too much plant now, you must convert that; but if you have only plant enough for your present trade, you will require a new plant for the new trade; and then you must make those loose boxes?

Trucks for loose boxes useless for any other purposes. Trucks in great demand.

But just look at a case that will arise every day; what are we to do with those trucks coming back from Rugby, when we are so pressed for trucks that we do know what to do? We cannot use them to go anywhere else. They are useless for the Leicester trade, and they must stand by till we want to send them to Rugby again.

5798. Do you imagine that loose boxes would not work upon any other than upon that line?

We found so much difficulty in keeping those boxes fast that the trucks wore out; they broke the sides of the truck in two; the trucks got out of shape. We tried next making the boxes fast together, and then they were so cumbersome that we could not lift them with the cranes, and the whole thing failed.

Mr. John Ellis.

Uniformity of Gauge.

5770. What we want for the coal is a continuous Gauge to Oxford and to Banbury. Our object is to get the coal to the market, and any obstruction afforded to it must fall upon the public.

Extension of Broad Gauge will create turmoil of trade.

5781. I am of opinion that if the Great Western had not made the Gauge that they have, the traffic of the country would be much more conveniently managed, and if it is allowed to extend any more, I can imagine the turmoil that must take place in the country.

The coals of Claycross Company travel 150 miles.

5802. The most extensive traffic in coals that we have now are those of the Claycross Coal Company, and theirs go now 150 miles or more. The Midland Company being amalgamated, they are taken up to Kilburn, near London, by passing over two railways. Some Stavely trucks come to Gloucester. It is 53 miles from Gloucester to Birmingham, and 42 to Derby, that is 95; and then Stavely will be about 30 miles from Derby, that is 125 miles, and now since the amalgamation of the Companies that traffic will be over one railway.

5806. But occasionally the coal-waggons pass over several distinct lines?

A great point to have one continuous line.

Joseph Pease, of Darlington, sends his coke to Gloucester; it comes on to the Stockton and Darlington; then the Great North of England and the York and North Midland; so that it comes over four lines. But it is a very great point to have one continuous line and with continuous management. We have a contract with Joseph Pease.

5807. Is that system likely to be so extended that any interlacing of the Broad Gauge would be very pernicious?

I have a perfect horror of it, as a railway director.

Mr. John Ellis.

5808. If the Broad Gauge gets thoroughly interlaced in the south and south-western district, and should it there be approved as a cheaper mode of traction, it will work its way farther north by new lines?

Economy of construction and working.

Yes; as a matter of business, if they could show it was cheaper, it would extend itself; but you cannot alter the tunnels, you cannot put down another Kilsby tunnel to bring the Broad Gauge through. I mentioned our little tunnel on the Leicester and Swannington; you could not put on the Broad Gauge there; it is but 12 feet wide, but it answers its present purpose very well.

Tunnels cannot be altered.

5777. Of course it is in a great measure a commercial question, and the Broad Gauge advocates assert that they can carry at much less per ton per mile than you can upon the Narrow Gauge?

I am not at all of that opinion. I think they have very considerable disadvantages, what the advantages are I do not know. But the very circumstance of their being obliged to haul those immense trucks, whether they are loaded or not, is a great disadvantage; there is such an immense amount of dead weight in the return trains and in the half-loaded trucks.

Disadvantages on Broad Gauge to have immense trucks loaded or unloaded.

5779. But, notwithstanding that, they have attempted to show to us that the cost of the haulage of goods trains is only half what it is upon the London and Birmingham Railway?

That is for you to judge upon; I am of a very different opinion; and I think if Mr. Brunel had not been of the same opinion he would not have made such a bargain as he made for the use of trucks upon the Bristol and Gloucester line. I should not think he can show that he can do it cheaper, and I believe not so cheaply as we can upon the Narrow Gauge, taking all things into

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Would not recommend intermediate Gauge for Midland.

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4431. From your experience of the Gloucester Station, are you of opinion that the want of an uniformity of Gauge is an evil of a serious description? Break of Gauge.

Yes, I think, when regarded in connexion with the advantages which railways ought to afford, it is of the most serious possible description. I have formed my opinion on what was daily brought under my observation with regard to all descriptions of traffic, and I should say that the want of uniformity strikes at the very root of the advantages which railways are calculated to afford; because among the peculiar advantages of railways is punctuality as well as despatch, whereas when you have a Break of Gauge it is quite impossible ever to insure punctuality, especially with goods, and for reasons which I can state to the Commissioners, and which I think will place it beyond a doubt; it certainly has been so at Gloucester. Want of uniformity in railways destroys punctuality.

4432. We shall be glad to have all your reasons in the fullest detail, as we understand you have turned your attention very closely to the subject.

Perhaps you will allow me to enumerate the different descriptions of traffic and how they are affected. In the first place, as to the passenger traffic, it is clear that

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Inconvenience in moving passengers.

Moving horses and carriages.

Merchandize trucks must be stopped, unpacked, and repacked.

there must be great inconvenience in taking a passenger out of one carriage and moving him with all his articles of luggage and all the accompaniments into another carriage, that is evident at once to a certain extent, and gives rise to delay as far as passengers are concerned: supposing you have picking up passengers in a train for between a quarter and half an hour on the average, but then horses and carriages always accompany passenger trains, and the delay is thus increased. With horses there is a risk of injury; and I have known two or three hours even occupied in getting a restive horse into a truck. Very often the owner is with the horse, and he is unwilling to let the train go unless the horse is in it. With regard to a carriage, the same thing occurs: the men may injure it in getting it on and off, and the owner is discontented and complains if the train goes without it, and that gives rise to further delay than takes place where you have only passengers to change. But with regard to merchandize, the evil assumes a totally different character: you stop your train; you have to take it to pieces and to disarrange it, to unpack the goods and repack them, and put them in other trucks of a different capacity and consequently take an inventory of the whole as you pass them over; it is a work of great time and requires the greatest possible care. Then you have to pack them up again and send them off; this also costs a great deal of money, and occupies a great deal of time. The goods are continually injured, and wrongly invoiced and misdirected, and it must always be so when the work is to be done in a hurry. But it is especially hurtful looking to the irregularity of the traffic to which it gives rise; and I will give this statement with the permission of the Commissioners, showing how irregularity must exist in consequence of the fluctuating character of the goods trains on all lines; there is no sort of average of goods trains, it varies day by day. I will read out the goods in the trains which arrived at Gloucester last week, taken by accident:—

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	Tons.	Cwt.
October 20th . . .	124	4
,, . . .	34	17
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On one day, therefore, the train which was 124 tons, is suddenly, without any apparent reason, reduced to 5 tons.

Variation in loads of goods trains.

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Now, in this week the fluctuations appear to be unusually great; but they are always of this character, though not always to the same extent. It is quite clear that with work fluctuating as this does it is impossible to fix any average force, with a view to economy, which shall be equal to the greatest amount of work; one day you will have half your porters standing still, and the next day you will have more work than they will possibly be able to do.

4438. Do you happen to know the gross load on each train?

Expense of porterage and shifting at 1*s.* a ton.

I shall be able to give you that. Now the expense of work conducted under these circumstances is very great; great is a vague term; it approaches to 1*s.* per ton, the mere expense of porterage and shifting; but that does not by any means represent the real expense connected with it; for instance, if your goods are three hours longer than they ought to be in going to Bristol, the carts are waiting there and doing nothing, expecting goods that do not come; and, above all, you thereby lose a great quantity of the traffic, because people will not use that conveyance which is so irregular if they can get any other, and this is equivalent to expense.

Mr. Wyndham Harding.

4439. By carts you mean road carts?

Yes, waiting to take goods to the warehouses and mills; so that the loss to the Company is very great by the irregularity of the traffic. The inconvenience to the public is to some extent represented by the loss which the Company suffer; to that extent the railway conveyance is not so effective as it might be. A break of the Gauge is precisely analogous to what takes place at a custom-house, supposing that custom-house to be well conducted and in a friendly spirit; goods are unpacked and enumerated, taxed, and allowed to pass on. With regard to every ton of goods that passes either way, the change of Gauge, measuring distances by Time's compasses, as the phrase goes, places towns frequently 50 miles further apart than they otherwise would be.

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There is one other branch of traffic which I have to touch upon, that is, mineral traffic. If you have to shift minerals, coals, or lime, it is clear that you do them such an injury that it is not likely you would have the traffic; under those circumstances you would, therefore, in order to avoid the shifting of the minerals, contrive a scheme for lifting the vehicle which they were in from one body to another. You must endeavour to do that by mechanical arrangements, because otherwise most likely, except under very extraordinary circumstances, it would preclude the traffic passing; and all these contrivances are liable to great objection, especially applied to cheap and bulky traffic, such as the traffic in minerals. Of course, in this description which I am endeavouring to give, I have assumed that everything is changed by hand, and that there are no mechanical arrangements adopted which will save the labour of trans-shipping. I will state the objections to them afterwards, if the Commissioners wish it.

Break of Gauge precludes mineral traffic.

4441. Do you imagine that it will be possible, with such a traffic as is likely to take place at Rugby, to give to each passenger his carriage to go to every one of the points diverging from that point?

Unless I knew all the points, of course, I could not

Mr. Wyndham Harding.

answer the question directly, but it is clear that there is already a considerable divergence at Rugby, and the number of carriages that are sent through may be regarded as an indication of the convenience which the clearing-house system affords to the public. I would remark that the difference between a Break of Gauge occurring at Rugby, and no Break of Gauge, and still the same convergence taking place, is this, that if there were no break as soon as ever the traffic coming through or into one channel became of any importance, immediately the remedy would be applied of sending the carriages through; whereas, if there were a Break of Gauge, the greater the traffic the more the inconvenience of shifting would be — in the former case the shifting which would take place would only be where the traffic was inconsiderable; whereas in the other case, it would be more felt as the traffic increased.

With break the greater the traffic the greater the inconvenience.

4442. Still there is reason to believe that all the great lines will have various branches, and that there will be more trunk lines communicating with them, and it does not, therefore, seem fair to assume that it will never be possible for the London and Birmingham, or any Company to supply carriages throughout, consequently you must be subject in all probability to a change of carriage at Rugby. At the present moment the Great Western Company change carriages upon their own line at Swindon and Didcot, and we are informed that no inconvenience is complained of if it be felt. Are you aware that those changes do take place?

The difficulty of trans-shipment which must exist where you have exceedingly large carriages, such as you have upon the Broad Gauge, is generally remedied as soon as possible, as far as first-class passengers are concerned; the inconvenience remains to the second-class, and their complaints are not regarded so much as those of the first-class; that gives a sort of reason why complaints are not heard so much in some cases

The inconvenience falls on second-class passengers.

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Yes, waiting to take goods to the warehouses and mills; so that the loss to the Company is very great by the irregularity of the traffic. The inconvenience to the public is to some extent represented by the loss which the Company suffer; to that extent the railway conveyance is not so effective as it might be. A break of the Gauge is precisely analogous to what takes place at a custom-house, supposing that custom-house to be well conducted and in a friendly spirit; goods are unpacked and enumerated, taxed, and allowed to pass on. With regard to every ton of goods that passes either way, the change of Gauge, measuring distances by Time's compasses, as the phrase goes, places towns frequently 50 miles further apart than they otherwise would be.

A break of Gauge, measuring by Time's compasses, places towns 50 miles apart.

There is one other branch of traffic which I have to touch upon, that is, mineral traffic. If you have to shift minerals, coals, or lime, it is clear that you do them such an injury that it is not likely you would have the traffic; under those circumstances you would, therefore, in order to avoid the shifting of the minerals, contrive a scheme for lifting the vehicle which they were in from one body to another. You must endeavour to do that by mechanical arrangements, because otherwise most likely, except under very extraordinary circumstances, it would preclude the traffic passing; and all these contrivances are liable to great objection, especially applied to cheap and bulky traffic, such as the traffic in minerals. Of course, in this description which I am endeavouring to give, I have assumed that everything is changed by hand, and that there are no mechanical arrangements adopted which will save the labour of trans-shipping. I will state the objections to them afterwards, if the Commissioners wish it.

Break of Gauge precludes mineral traffic.

4441. Do you imagine that it will be possible, with such a traffic as is likely to take place at Rugby, to give to each passenger his carriage to go to every one of the points diverging from that point?

Unless I knew all the points, of course, I could not

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answer the question directly, but it is clear that there is already a considerable divergence at Rugby, and the number of carriages that are sent through may be regarded as an indication of the convenience which the clearing-house system affords to the public. I would remark that the difference between a Break of Gauge occurring at Rugby, and no Break of Gauge, and still the same convergence taking place, is this, that if there were no break as soon as ever the traffic coming through or into one channel became of any importance, immediately the remedy would be applied of sending the carriages through; whereas, if there were a Break of Gauge, the greater the traffic the more the inconvenience of shifting would be — in the former case the shifting which would take place would only be where the traffic was inconsiderable; whereas in the other case, it would be more felt as the traffic increased.

With break the greater the traffic the greater the inconvenience.

4442. Still there is reason to believe that all the great lines will have various branches, and that there will be more trunk lines communicating with them, and it does not, therefore, seem fair to assume that it will never be possible for the London and Birmingham, or any Company to supply carriages throughout, consequently you must be subject in all probability to a change of carriage at Rugby. At the present moment the Great Western Company change carriages upon their own line at Swindon and Didcot, and we are informed that no inconvenience is complained of if it be felt. Are you aware that those changes do take place?

The difficulty of trans-shipment which must exist where you have exceedingly large carriages, such as you have upon the Broad Gauge, is generally remedied as soon as possible, as far as first-class passengers are concerned; the inconvenience remains to the second-class, and their complaints are not regarded so much as those of the first-class; that gives a sort of reason why complaints are not heard so much in some cases

The inconvenience falls on second-class passengers.

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as in others; but it is quite clear that, though it may be impossible to send carriages in all directions, it is infinitely more difficult to do it where you have a large vehicle holding twice as many people, and occupying twice as much space than where you have a smaller vehicle.

4443. Then you are disposed to think that, with the description of railways we shall have for the future, the smaller the carriages the greater the convenience will be to the public at large?

Small carriages convenient for branch traffic.

For the branch traffic undoubtedly.

4444. Because you afford greater facility to the passengers that are to be carried through?

Yes; you accommodate your railway to the passengers that you have to carry; there is an advantage in that in regard to economy and convenience.

4445. You speak of the inconvenience of the change of truck in the case of private carriages where a Break of Gauge occurs; would not that be remedied by allowing the passenger trucks of the Narrow Gauge to be carried upon the trucks of the Broad Gauge; it merely adds to the dead weight, and there is no great loss of time?

Objection to carrying narrow truck on broad truck.

Possibly with reference to private carriages such an arrangement may be admissible; but it is not admissible with reference to goods trucks in my opinion. As it is we have considerable fear very often from the light lashings which attach a gentleman's carriage to the truck; an accident very rarely now happens, but still it is sometimes hardly safe; if the train were suddenly brought up by anything like a collision, there is no knowing where a private carriage would be found afterwards, and that danger would be increased if the Narrow Gauge railway truck and gentleman's carriage were perched on a broader railway truck.

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4448. With regard to the inconvenience of removing goods from one Gauge to the other, does not that resolve itself into a question of the cost of removal?

I do not think it does, I think both to the Company and the public it affects the whole advantages which the railway ought to afford them. It affects the revenue of the Company and the traffic of the district.

4449. I do not think that any mechanical arrangements, consisting of wheels capable of running on both Gauges, can accomplish the object for which they are designed, and my reasons are principally these: I do not mean to say that it is a matter of difficulty to shift the body of a carriage from one carriage to the other, I do not think it is. I think I have myself designed a machine, and other people have no doubt done the same, which overcomes the difficulty to a great extent, perhaps altogether; you cannot be sure of this though till you have worked it for a few months or a year; but, as far as the model goes, it appears to have overcome the difficulty; but the reason why I think such arrangements on principle never can generally apply, is this, that they involve two sorts of stock, one the ordinary or permanent stock, if we may so call it, and the other the shifting stock capable of undergoing this process of trans-shipment. It also requires the concurrence of a great many Companies, not merely to consent to such stock being built, but to their continually, even daily, and all their servants taking care that it is used as it is intended to be used, and for that purpose only, otherwise the arrangements will fail altogether, and rather increase the evil than mitigate it. Now supposing all the railways were under one management, even assuming that to be case, I do not think it would then be practicable to bring into use two sorts of stock. We find already, that there is a great difficulty in carrying on a goods traffic, in getting hold of any stock at all from the fluctuating nature of the traffic, especially the extraordinary rapidity with which everything goes on; in the goods shed you get hold of the first goods truck you can, and continually those out of repair are sent, although contrary to order; and the necessity of thus using the

Shifting bodies objectionable; involve two kinds of stock.

Even if all railways under the company, scarcely practicable.

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first truck that comes to hand without the distinction is shown by the clearing-house system, which many Companies were originally averse to, but which they were subsequently obliged to adopt. The Great Western were against it at first at Bristol, but in three weeks they were obliged to give way. They found it impossible when stock was there not to seize and use it in spite of all regulations to the contrary, and I feel satisfied that you cannot keep in use all over the country, or even at the principal stations of the country, two sorts of stock, each of which shall be applied to a particular traffic of the district of the opposite Gauge. For that reason, I think that mechanical ingenuity is almost thrown away upon the subject, because when you have overcome the apparent difficulty the real difficulty remains. But at the same time, I do not mean to say that the arrangement should not be tried with regard to particular branches of traffic. It is the only thing left for you to do; if both Gauges continue in use it must be tried, and you must get it into use as well as you can, but I do not think it is applicable to miscellaneous traffic.

Clearing-house system adopted in consequence of stock borrowed without leave.

4454. I will put the question in another shape: supposing it were a profitable trade for the Midland Company to carry coals with new stock, do you not imagine that they would construct it?

I think they would hesitate to do so, because the coal owners have so often tried those shifting bodies, and I do not know a case in which they have succeeded.

Shifting bodies mechanically possible, but a commercial inconvenience.

4456. Nobody says that the arrangement is mechanically impossible, but it is commercially an inconvenience and expense.

4457. At the present moment I assume that the Midland Counties have not stock for that traffic; they must create it, and it is a question of expense whether it is a more costly description of stock than they are now using; if it is not, they will use it?

They would dislike it on account of its being different. It is very undesirable to have two sorts of stock; it is very rarely, if ever, found to answer.

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4459. Is there any reason why the shifting stock should not be used upon other parts of the line?

No; but if it was used for the ordinary traffic of the line, *not* having to pass a Break of Gauge, if it was sent away whenever traffic came in like common stock, it would not be there when it was wanted for the other traffic, *having* to pass the break, for which it was expressly intended.

4460. Supposing the whole of the stock were made of a shifting character, would there be any harm in that? Supposing you now had to construct stock for any railway in the kingdom, would there be any reason why it should not be made of the shifting description?

It would be more expensive and less secure.

Shifting waggons heavy and expensive.

4462. I have made models of shifting waggons and tried the thing in every possible way, but I found that it always produced a somewhat heavier and more expensive vehicle. There is also this to be said, that you must allow a margin of reserve for each description of stock. The introduction of a new description of stock would therefore lead to expense.

4464. We have been told by a celebrated engineer, that he could contrive such machinery at Rugby, and that he could, in half a minute, shift any quantity of goods, the larger the better, at a penny a ton; that is no great cost?

No; I think that it is possible to shift an individual ton of goods or a great many tons of goods for much less than a penny, merely speaking of the mechanical expense of lifting the truck and letting it down. I should say less than a farthing; but that does not involve the whole expense of the trans-shipment: the arrangement of the train, to begin with, is an expense—the moving it backwards and forwards.

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4465. That is not a matter of necessity, you may move the machine backwards and forwards?

If you are to use a mechanical contrivance, I should say it would be better to move the truck.

4466. Except that moving the truck disorders your trains?

Yes, but it would be better to move the truck than the machine which would be the heavier. That, however, does not represent the labour that would have to be employed; and then I would take the case of the machine getting out of order; his half a minute would be a week. I observed a similar statement in Mr. Gooch's evidence, that he would shift a train of half a mile long in a minute. I find that he could do that with 1500 porters; if you had that number you could do it for a wager. I do not think these statements go for much, they may be abstractedly true, but I do not think they apply to the case.

Finds it would require 1,500 porters to move train mentioned by Mr. Gooch.

4467. The engineer referred to has had considerable experience in shifting trucks, and he is no bad authority in regard to the cost?

I think a penny is liberal for the mere labour of shifting by machinery.

4468. He includes the whole cost. He says that the cost to the coal owner or the consumer would be a penny a ton.

It is clear that it must be a hypothetical calculation, because he must assume a certain quantity to be shifted, otherwise he has no divisor. I cannot tell how he made his calculation, but it is clear that he assumed a large quantity to be shifted.

4469. He assumed a large quantity, and nothing but a large quantity would make it an evil?

Yes, but the evil prevents the trade from ever coming;

you would never have to apply it, because the trade would not come as long as you had that obstruction. Mr. Wyndham Harding.

4470. There are other ways of doing it, you may put the whole truck upon the Broad Gauge; that is open to great objection in the first place on the score of safety. I do not think we are justified in tampering with the safety of the trains by an arrangement of that sort, perching a heavy truck upon another, and then fastening it as you best could to the other truck, would by no means form a safe train; if there were a sudden check there would no doubt be a fearful accident. In the next place it would be inconvenient because it necessitates the lowering of the loading, and I think, coming from advocates for the Broad Gauge, who have made such great sacrifice in order to keep the centre of gravity low it is not quite consistent. I went yesterday to see the apparatus for running the Narrow Gauge waggon on to a Broad Gauge truck. I tried the same thing myself before, and found certain difficulties which made it necessary to abandon it, and I found my views confirmed by what I saw yesterday. The Broad Gauge truck has no springs or buffers at one end, therefore it could not run, it is an apparatus which does not show how the arrangement could be applied.

Putting much on truck not safe.

4472. They might apply buffers to that?

There might be shifting buffers of course. There is another evil; all these things having to be shifted, they are always liable to be out of order, and it affects the safety of the traffic; the less you have to adjust the better. And there is another great objection to the system, and that is this, that it does not admit of reciprocation. True, the Narrow Gauge trucks may run upon the Broad Gauge trucks, supposing for the sake of argument, that to be a proper arrangement which I do not think it is, but the Broad Gauge trucks cannot run upon the Narrow, therefore the difficulty recurs. And again when those Narrow Gauge carriages arrive at the Broad Gauge, they would be perched up above the platforms—the waggons would have to be taken off one level and

The less to be adjusted the better.

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put on to the other, which would involve great labour. I do not think it is feasible to run the Narrow Gauge waggons upon Broad Gauge trucks.

5270. Will you proceed with anything you have to suggest to the Commissioners?

Best point for Break of Gauge.

With regard to the point of the Break of Gauge, supposing the Break of Gauge to continue to exist, I would merely wish to remark, that as the subject appears to become a little complicated when you attempt to separate the quantities re-assorted, and the quantities which go through without re-assortment at any particular focus of traffic, I think it is necessary to keep in view this plain principle: that it is not the quantity re-assorted which you have to consider, but the quantity left, and which is not re-assorted, because that is the quantity which would be affected by a Break of Gauge, and which is saved trans-shipment by a continuity of Gauge.

5271. By the "quantity left," you do not mean that left at the station?

No. I mean that the balance of the whole quantity passing through that station, which is not re-assorted, is the quantity to keep in view when you are comparing the advantages and disadvantages of different points of trans-shipment.

5272. Do we understand you to mean the quantity which goes through without any alteration?

Yes, no matter how much is reassorted.

5273. Except so far as the question of proportion may influence it?

Yes, but still it is the proportion of the two balances at two particular places which are not re-assorted, which requires to be taken into account. As to trans-shipment, I should wish to say that I had considerable experience of that, both as to passengers and goods, at Greenock, where we found ourselves unable to compete

with a slower and less safe conveyance, in consequence of the trans-shipment to which we were subject at Greenock. Mr. Wyndham Harding.

4497. Suppose a Break of Gauge were to take place in consequence of the line being made from Oxford to Rugby, are you of opinion that the change, as far as regards the convenience of travellers and the interest of merchants, should take place at Rugby or at Oxford?

That involves the question of, whether the change should take place where there is a number of converging lines, and what is called a focus of traffic, or not. I think it is obvious to common sense that the change should take place, if there is to be a change, where there is least traffic to be transferred. The doctrine of focuses, as applied to goods, in my opinion (I do not wish to speak disrespectfully), is based on an utter misapprehension of the facts, and I have made out this statement in proof of what I say. For the last week, the Birmingham and Bristol received from other railways, or gave to other railways at Birmingham 920 tons of goods; out of those there were re-assorted, in the manner described the other day, five tons and a half. I am causing statements to be made out of how that takes place at Birmingham, with other lines, and I am certain it will be found that not one-fiftieth of the goods passing through are ever touched there: therefore, as regards the goods, the doctrine of focus is founded upon a total misapprehension of the facts of the case, from not knowing how the traffic is conducted; and for that reason, I think that Oxford is a better place for the change of Gauge than Rugby, because there would be less cross traffic. By parity of reasoning, I conceive Bristol to be a better place than Birmingham or Gloucester, and I found that opinion upon this, that there is far less cross traffic at Bristol than there would be at Birmingham or Gloucester. It appears from these figures showing the actual traffic last week, that the cross

Change should take place where there is the least traffic to be transferred.

Mr. Wyndham Harding.

Goods transferred at Birmingham, 920 tons; at Gloucester, 685 tons; and at Bristol, 51 tons.

traffic of the Birmingham and Bristol Railway was 920 tons at Birmingham, it was 685 tons at Gloucester, and only 51 tons at Bristol, where we use the same station as the Great Western; and that seems to be conclusive upon that question. I cannot conceive that there can be a doubt entertained upon it: and the statement I have given is the average result; I have often tried it.

4498. If there were much re-assortment, you would then be of opinion that it would be better to have it, I suppose, at the focus of traffic?

If all the goods, or the greater part of the goods were re-assorted, it would be better, assuming that state of things; but the reverse is the fact.

4500. Supposing the Great Western were to form the line from Rugby to Oxford upon the Narrow Gauge, it might not be convenient for them to take carriages from every line that converges at Rugby at the exact moment of their arrival; their trains might start at a different period, or a different hour, and there would then be a detention of the passengers, whether there was a Break of Gauge or not?

Inconvenience to passengers to move luggage at break.

It would afford the passenger much more time to have no break; for it would still be inconvenient to him, if detained an hour at the station, to watch his luggage, and see everything moved into another carriage. Of course it is of less importance than if the Break of Gauge causes not only the inconvenience of the change of carriage, but a delay of the traffic.

4501. Judging from the enormous increase at the port of Southampton, and the number of schemes which are now on the *tapis* for joining Southampton with the North, I suppose it is anticipated, by com-

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mercial men, that a very great increase of traffic will take place at Southampton, and if so, I do not see any reason why the same increase of traffic, and why the same necessity for connection with the North should not occur at other points on the south coast, where advantages as to port room, and so on, are afforded. I may, perhaps, state two or three figures showing the great increase at Southampton. In 1832 (this is what is stated by the Collector of Customs,) the trade was represented by 62,000*l.*; I suppose that was the declared value of the exports most likely, but 62,000*l.* is the figure he gave. The same item in 1841, was 527,000*l.*; in 1844, 1,500,000*l.*; and in 1845, 3,000,000*l.* If it goes on at that rate, it is clear it will require connection with the North and everywhere else.

Southampton will require direct communication with the North.

Prospects of unrestricted Gauge.

4507. I have drawn out this map [*producing the same*] more than three months ago, before the Commission was appointed, with a view to show the immediate tendency of the Narrow and Broad Gauge to spread themselves into a new country. These were the schemes I took from advertisements in the newspapers. These parties [*pointing to the map*] announced their determination of adopting the Broad Gauge, and these announced their intention of adopting the Narrow Gauge.

4508. The blue are the Broad Gauge?

Yes. These circles round various towns show the points of intersection.

4509. Intersection of the Narrow Gauge?

Yes, between Broad and Narrow.

4510. Have you reason to suppose that those various schemes stated in the papers are now afloat?

Projected interlacings.

Yes; those, and a great many more; and, unless controlled, the same interests would lead to the same Gauges being adopted as before. This is based entirely on the evidence of advertisements in the papers. I constructed that map for my own information at the time the schemes were under consideration. It appears, starting

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from Oxford, that a Broad Gauge line, a bill for which has been passed, is projected from Oxford to Rugby, and that a branch from this to Birmingham is also projected, passing through Warwick, which has also received the sanction of Parliament, and is subject to the decision, as regards the Gauge, of the Board of Trade. Another Broad Gauge line, extending from Oxford by Worcester to Wolverhampton, has also received the sanction of Parliament, subject to the same conditions as to Gauge between Worcester and Wolverhampton. A Broad Gauge line is projected from Oxford to Cheltenham, and so on to Gloucester. A Broad Gauge line is projected from near Worcester to near Ludlow. A Broad Gauge line is projected from Bristol to Monmouth, Hereford, and Leominster, joining the Worcester and Ludlow line near that place. A Broad Gauge line is also projected from Gloucester to Hereford. A Broad Gauge line is projected from Standish, proceeding by Newport, Cardiff, and Neath, into Pembrokeshire. From Ludlow, a Broad Gauge line is projected by Newtown to Port Dynllaen. Another Broad Gauge line is projected from Ludlow by Shrewsbury and Whitchurch to Chester, near which a branch leaving it, proceeds by Tarporley to Manchester on the one hand, and to Liverpool on the other, crossing the Grand Junction near Northwich. In the foregoing statement, *all the places named as those through which the lines in question pass, are points of intersection with other projected Narrow Gauge lines.* This statement refers exclusively to projects north of Bristol and Oxford.

Remedies.

4515. Have you at all considered whether inconvenience would result from having a double line of rails upon the same line of railway?

Yes, I have; there are two ways proposed of doing it, either by using a third rail, as it is called, or by laying a complete Narrow Gauge railway within the Broad Gauge. The first way, I think, is hardly worth considering; all persons who have considered the sub-

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Third rail system, objections to.

ject, regard it as what is called a bad job; the lines would be out of centre; you could not carry with any propriety, with one engine, vehicles on the two Gauges by that means.

4516. You might avoid that, might you not?

Not very well, because in the case of accident you want an assistant engine. An engine on one Gauge may break down, and unless you buff together, you cannot assist that engine; the next train coming up on the other Gauge cannot assist it. Then at stations you would have to buff. I have myself seen persons killed from the stock not buffing together: we had some of that description on the Glasgow and Greenock: it was most dangerous, and we were obliged to alter the construction of the buffers to make them buff together.

4518. I think the three-rail system is not applicable, except to a very small extent, and for a few miles perhaps. I do not mean to say that it is absolutely impracticable.

4519. It is not so good, you think, as having a double rail within the other?

No.

4520. But there are objections to that?

Objections to double rail within Broad Gauge.

In the first place it makes the permanent way more difficult to be kept in order. As a proof of that, I may state that it was tried on the Bristol and Gloucester line by Mr. Brunel; he was obliged to lay, in consequence of an arrangement with a colliery, a Narrow Gauge line within the Broad Gauge: the Narrow Gauge is never used. The contractor for the permanent way asked for an increase of 50 per cent., in consequence of the inside rails being in his way; and the demand was sanctioned by Mr. Brunel, although the inner line was never used; and therefore, no doubt, an inner set of rails are in the way if you want to repair the road, if they remain there permanently.

4523. I find that where two lines leave or come in to two lines, if they are put on one Gauge, there are six

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crossings; if the Double Gauge system is introduced there are 28 crossings, which is apparent by this drawing [*producing the same*].

4524. The number which any carriage has to go over is increased treble?

I am taking the absolute number of crossings now; it would vary under different circumstances. These black lines represent the two Gauges; if you count the crossings of the single Gauge you will find six. Let us take the Broad Gauge, for instance; there are six; whereas, if you count the whole number of crossings, as it now stands there are 28 crossings.

4525. We nearly had a serious accident on the Bristol and Gloucester, near Gloucester, from a crossing of that sort, and I sent up the next morning, and had a drawing taken, which I have with me. This is a drawing [*producing the same*] showing the extreme complication when you adopt the Double Gauge system at a crossing.

Practical difficulties in the way of keeping double stock and double stations.

4529. Those are the principal objections to the Double Gauge arrangements, added to this, which I think more important than all the others, that you require two stations, or two kinds of stock; if you have two kinds of stock in one station, you must have two stations. I remember, in Mr. Laing's statistical paper on railways, he stated that the average of the cost of stations per mile on various railways was 3000*l.*, and that has to be added to the 4000*l.* or 5000*l.* per mile, which the double cost of the permanent way entails.

4530. Why is it impracticable to have the two kinds of stock in the same station?

Because when you want one sort of stock you are always getting hold of the other; it is always in the way. We will say certain goods come in at Birmingham (if the Double Gauge existed there) to be sent to Exeter. The eight or nine waggons next the platform are ordinary Narrow Gauge waggons; you must then

move all those out of the way, and go to some distance and fetch in the peculiar waggons suited for this particular trade coming in. The next train may come in with goods for Sheffield, then you have to fetch back the other set, and that going on all day is sufficient to make the arrangement most objectionable. Mr. Wyndham Harding.

5298. Taking the existing Broad Gauge lines at 242 miles in length, the whole alteration might, I think, be made for 439,000*l.*; but it would be proper to add, as is usual in these cases, a round sum for contingencies. **Uniformity of Gauge.**

5301. I make the sum on 248 miles in length to be about 520,000*l.*, necessary for the alteration of stock: so that in round numbers, I think, 1,000,000*l.* may be said to represent the expense of altering the existing Broad Gauge lines to Narrow Gauge lines: the entire expense of all sorts. Then, as I have said before, I think it may be done as it was done on the Northern and Eastern, without obstructing the traffic at all—without incurring any danger.

4427. Are you prepared to admit that the London and Birmingham would require three engines to draw 200 tons? **Power and Construction of Engines and Carriages.**

I do not know enough of the locomotive department of the London and Birmingham to say; but upon the Bristol and Gloucester we have the most powerful Broad Gauge engines, at least as powerful as any that are constructed; they are new engines, constructed with all the experience of the past; and I know that the best Narrow Gauge engine of the Birmingham and Gloucester has met them, and taken away a train which the Broad Gauge engine could not take or bring. **Has known a narrow engine move a load which broad could not.**

4490. Do you not imagine that the circumstance of having six wheels and three axles to the goods waggons tends to give greater safety?

We have only four wheels on the Bristol and Gloucester—a Broad Gauge line.

Mr. Wyndham Harding.

4586. Then you are not prepared to admit that the Great Western engines possess much greater power than the Narrow Gauge engines?

I am not prepared to admit it, because my observation tells me the contrary, as far as it has gone.

4608. I would merely remark, with regard to the Bristol and Gloucester stock, which is a new stock, and built on a uniform plan with the Great Western (for the contractor would naturally be anxious to avail himself of the result of his experience, and his experience has been on the Broad Gauge), that the dimensions of the driving-wheels, and of the wheels of the carriages are those which may be adopted, and which are frequently adopted, by the Narrow Gauge lines; they are not of greater dimensions, such as are beyond the reach of the Narrow Gauge.

Driving wheels of latest Broad Gauge stock not larger than what adopted on Narrow Gauge.

4609. What are his driving-wheels, 6 feet 6 in.?

Six feet 6 inches, and his carriage-wheels 3 feet 6 inches.

Convenience and comfort.

4476. Have you turned your attention at all to the advantages or disadvantages of one Gauge over another in a commercial point of view?

Yes, I have; in fact I could scarcely avoid making the comparison, being at a place where the two Gauges join. With regard to passenger traffic, the difference between the conduct of the passenger traffic on the one Gauge and the other is, that with the Broad Gauge the traffic is conducted in much larger vehicles than with the Narrow; they hold double the number of people, and are one-third wider, which is found, I think, not to be adapted to the ordinary passenger traffic. We find that the middle seats are dark and inconvenient, and not liked by passengers; passengers generally do not sit in them if they can help it: this remark applies to the width of the stock. As regards the general size of the stock, we find the carriages too large; we cannot

Broad Gauge carriages too large.

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fill them; and if the passengers rather exceed a certain number, and we have to add one more, we must add an unwieldy vehicle which holds far more than we want; and, indeed, for some lines, the carriages are found to be altogether too large.

5262. As the result of our practical experience of the Broad Gauge as applied to mineral waggons, I may state that the Bristol and Gloucester line goes through a coal-field. We therefore sent to the north, to the engineer of the Stockton and Darlington Railway, who was supposed to have the greatest experience in the construction of coal waggons, and desired him to make the most suitable waggon for the coal trade, on the Broad Gauge. We have tried those waggons, but, practically, we find that they do not give satisfaction. We find that this waggon, so constructed, is weak, and that the repairs upon it are very expensive in consequence of the weakness of its construction; that, in order to give it equal strength to a Narrow Gauge waggon, it should be made considerably heavier; and so the proportion of tare to net should be increased. We also find that the height of the hopper, the depth of the body of the waggon, gives rise to injury in the coal. The coal owner tells us that it makes his coal in the market worth one shilling a ton less than before. He also complains that, having to bring those Broad Gauge waggons to us by means of horses, whereas formerly one horse could draw down waggons holding 12 tons of coal when he had the Narrow Gauge there, now his one horse can only bring 7½ tons of coal; and he demands additional payment on that account: so that we have found the Broad Gauge certainly not so suitable to the trade with the colliery as the Narrow Gauge was found to be.

Coal waggons too heavy.

Coal injured, and worth 1*s.* less per ton.

One horse draws 12 tons coal on Narrow Gauge, 7½ tons on Broad.

Safety—Curves—Speed.

4482. We find that the most frequent causes of accidents on railways are collisions and the breaking of axles. Now it is clear that if you have the train unnecessarily heavy, it is more likely to lead abstractedly to

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collisions than a train not so heavy: we find that the trains on the Broad Gauge are much heavier than those on the Narrow Gauge.

4483. You have stated that you think safety is decreased by the weight of the carriage: is it practically so?

Practically I cannot say there is any difference, with regard to safety, between the two Gauges; abstractedly, I think that there are reasons for supposing the Broad Gauge to be the least safe of the two, because you cannot stop a train of 66 tons so soon as you can stop a train of 42 tons, and its momentum is greater in case of a collision. The breadth of the Gauge gives no strength, but the reverse; and I consider that, as regards the strain on the axle, taking the matter abstractedly, the width makes the accident somewhat more probable. A broken cranked axle often causes accident.

Heavy trains more difficult to stop than light trains.

Weight.

4493. Is not weight an element of safety?

It is also an element of danger.

What is unsafe in regard to the weight of vehicles is the coupling together a light vehicle and a heavy vehicle, and that accounts for the accidents which occur with the light vehicles on the Great Western; because, weighing four tons, they are next an engine and tender weighing 30 tons. It is not the absolute lightness of the vehicle, but its comparative lightness which is objectionable.

Danger of coupling light vehicles and heavy vehicles.

4543. We have been told that there are no instances of Broad Gauge engines getting over an embankment?

I have seen a Broad Gauge engine fall over an embankment, and in so doing cut a complete somerset in the air.

I saw it do it; it fell into a house on its chimney. Undoubtedly a certain margin is necessary beyond the rails for safety, and the practice of all engineers confirms it.

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4545. We have been told that the embankments and cuttings of the Broad Gauge are not necessarily wider than those of the Narrow Gauge; but for the same degree of safety I presume they should be wider?

Certainly; they must be a great deal too wide for the Narrow Gauge if they are wide enough for the Broad Gauge.

Speed.

4552. I do not admit that there is an increased speed upon the Broad Gauge; I do not think there is. I think the Northern and Eastern is at this moment running faster, or as fast.

4553. We have nothing in evidence to show that to be the case?

I thought Mr. Bidder stated the other day that they were going at 46 miles an hour.

4577. In the point of being more costly in first construction, does it appear to be made out, by your own statement at least, confirmed by other statements, that the Great Western has a disadvantage?

My notion of the comparative advantages, I believe I stated to be this; that in regard to absolute speed, the point has not been determined; the experiment has not yet been made under similar circumstances. The excellent gradients and good curves of the trunk line of the Great Western, on which the bulk of the traffic passes, are decidedy advantages that they possess over any other line in the country, and those advantages would make themselves felt both in economy, speed, and command of locomotive power on any Gauge.

Curves.

5278. With regard to curves, as on the Bristol and Gloucester line, we have, I believe, the sharpest curves which have yet been introduced on the Broad Gauge:

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it may be as well that I state the result of my observation there. We found on the Bristol and Gloucester line that we had the greatest difficulty in getting the carriages round the curves, in the sidings at the stations particularly, where the sharpest curves occurred; and that we were getting them and the engines off at those places far more frequently than is ever found to be the case on a Narrow Gauge line.

5280. I may state that on the Bristol and Gloucester line, in a case where two engines were coupled to a train, I have seen one engine in going round the sharpest curve, force the permanent way open for a great distance and let the whole train down into the ballast by the great pressure on the outer rail going round the curve.

5281. The great uneasiness of the motion of the carriages, which is found to take place on going round the sharp curves on the Bristol and Gloucester line, is, I think, an indication of the difficulty which the longer axle and longer carriage have in adjusting themselves to sharp curves.

5282. Can you speak to that as a fact, that great uneasiness is felt in the passenger carriages?

I can, most decidedly. Very great uneasiness is felt, and the feeling amounts to one of great insecurity frequently. I would also state, that common experience at collieries, in all engineering works, shows that the narrower the Gauge is the sharper are the turns which you can take, and I think theory leads to the same result.

Uniformity of Gauge.

4458. Suppose, at the present moment, the two Gauges were nearly balanced, and were intersecting each other all over the country, all your stock must be of the shifting description?

That would be such a complete mess that I do not know what would take place. I cannot conceive what

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would be done in that state of things. Suppose the machine and apparatus made, they would have to keep the machine and the shifting stock in order and in use at every station in the country; it is just possible that such a state of things might arise; but I think the effect would be that, in six months, it would be found that one Gauge or the other must give way, and uniformity be established.

Probable effects of interlacing Gauges.

4463. That would not be the necessary consequence of their interlacing with each other?

I think the consequence would be, that one would have to give way if they interlaced; it would be manifestly absurd to attempt to carry on the traffic.

4547. Are you of opinion that a diversity of Gauge is so great an evil as to render it desirable now to take some strong measures for the adoption of an uniform Gauge?

Yes: I think looking forward to the extension of the railway system, and looking back at the progress of the trade of the country, which, taking a very few figures, points out that the traffic on railways will increase so enormously, that they will to so great an extent supersede all other modes of conveyance, and become of such vital importance to the trade of the country (as to the defence of the country I do not feel myself competent to speak), that it is desirable that the advantages which railways are calculated to afford should be realized to the utmost extent; and that all impediments or drawbacks to those advantages should be removed; and I think the diversity of Gauge is the greatest possible drawback to that; and I confess I do not see any use in it, because I do not think that the Broad Gauge has introduced one great improvement, they have all been introduced on one Gauge as well as on the other. There have been very able men connected with the Broad Gauge, and so also on the Narrow. The figures,

Thinks the Broad Gauge has not produced one great improvement.

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looking back, on which I base the opinion I have mentioned, are these. The population has increased, from 1820 to 1840, from 14,400,000 to 18,800,000; the exports in official value, which gives the weight of the traffic, have increased from 42,800,000*l.* to 109,700,000*l.*; the imports from 29,681,000*l.* to 60,346,000*l.* There are now 700,000,000 lbs. of cotton worked up, in the place of 151,000,000 lbs. in 1820; and there are 69,000,000 lbs. of foreign wool in the place of 7,000,000 lbs. The increase of passenger traffic caused by railways has been, I suppose, on the average at least fourfold. An analogous result, though not to the same extent, I think, will take place with regard to goods. Looking at these facts together, and considering that a diversity of Gauge affects every ton which has to pass the break of Gauge, I think the aggregate evil will be so great as to be most serious in its effects on the internal commerce of the country; I would also add that it seems to me that it is impossible to restrain the commercial wants of the country within certain limits; and say, this district requires no greater accommodation, or no communication with that district, because we perpetually see trade finding new channels for itself, new districts for itself, and new outlets for itself. For instance, Southampton is a new outlet, so that any one who should have said 20 years ago, that there was no necessity for any connexion of Southampton with the North would be quite wrong now; and I think, now, if we attempt to isolate any district of the country, we shall find in a few years that that will do a great injury to the country at large, and to that district particularly. As another example of what I mean, I would refer to Glamorganshire, where new districts are being opened up, requiring communications in all directions.

Considering diversity of Gauge affects every ton of goods, it will produce serious effect on internal commerce.

Economy of Constructing and Working.

4408. Have you kept any accounts which will enable you to give a comparative view of the cost of locomotive power upon the Glasgow and Greenock, with the cost of locomotive power upon lines in the South?

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Generally speaking, I can state this as the result of my own experience; when I left the Glasgow and Greenock Railway, where coke was somewhat expensive, about 18*s.* per ton and not very good, I found that the passenger train ran, as regards locomotive power, at 8*d.* per mile run, with a very heavy traffic. I came to the Bristol and Gloucester Railway where the coke was cheaper and the traffic much lighter. I found the locomotive power costing 11½*d.* per mile; but it must be remarked that on the Bristol and Gloucester Railway they were working under contract, and the 11½*d.* included something more than the 8*d.* to the extent of perhaps 1*d.* per mile run, so that the comparison should be as 8*d.* to 10*d.*

4410. Then you do not know the amount of profit to the contractor?

No, I do not; but I see from Mr. Gooch's statement that 11*d.* per mile is the cost of the train upon the Great Western; and from the traffic being lighter on the Bristol and Gloucester, I have no doubt that there was a margin of profit. I have frequently compared the locomotive expenses in detail on different lines, but the circumstances of the lines and the modes of keeping the accounts differ so much on the various railways, that, as far as my experience goes, I believe it to be quite impracticable to make any fair or precise comparison between the expenses of locomotive power as presented in the detailed statements made by the locomotive superintendents.

I have accordingly made up the following Table from the published accounts of several Companies, and my knowledge of the circumstances and charges of the different Companies convinces me that the per-centage of the locomotive expense to receipts, which is higher on the Great Western than on most of the Narrow Gauge lines in the Table, is not be accounted for by the charges of the Great Western Company being *lower* than those of other lines. The charges on the Great Western are indeed generally considerably higher than on the lines with which I have compared it: the London and Birmingham, for instance.

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TABLE showing Receipts and Locomotive Power, per mile, on several Railways during the half-year ending 31st December, 1844.

Name of Railway.	Length in Miles.	Gross Receipts per Mile.			Cost of Locomotive Power per Mile.			Ratio of Locomotive Power to Receipts.
		£	s.	d	£	s.	d.	
London and Birmingham Narrow Gauge . . .	120	3,753	19	10	301	4	4	8
Grand Junction . . .	119	1,908	3	0	186	5	6	9¾
London and South Western	93	2,034	13	6	208	18	8	10¼
Midland	179	1,524	7	3	122	3	9	8
North Union	32	1,429	13	9	92	13	1	6½
Hull and Selby . . .	31	1,293	11	7	104	7	8	8
Great Western Broad Gauge	220	2,001	12	2	179	19	8	9

Economy of Working.

Five first class, nine second class, average for Bristol and Gloucester trains.

4476. I find on the Bristol and Gloucester we had only five first class and nine second class passengers for two months on the average for two of our trains; and we cannot carry less than a carriage capable of holding 32 first class and 72 second class for those five and nine passengers, which was overshooting the mark as far as those trains were concerned, that is, as regards passenger traffic. Then we come to the horses: we find that the Broad Gauge vehicle will hold four horses; but we never have four to send, except at times of fairs; therefore we find we take a vehicle weighing 5 tons for the conveyance of one or two horses, which is the usual number, whereas upon the Narrow Gauge a vehicle weighing 3 tons will convey the same number, which is all we want. The same with respect to the truck on the Broad Gauge; they have a truck which weighs 4 tons 2 cwt. for a gentleman's carriage; on the Narrow Gauge we have a truck of 3 tons which conveys one gentleman's carriage just as well; that is as regards passenger traffic. Then we come to the goods traffic: we find that we have a waggon capable of holding in the Broad Gauge a loading of rather greater weight, and of somewhat greater area: the widths are in the pro-

Horses.

portion of 7 feet 3 to 8 feet 6, or something of that sort; the lengths are unlimited, on either line you may make them as long as you like; but we find that those waggons on the Broad Gauge are unnecessarily heavy. For instance, on the Bristol and Gloucester they have two sorts of waggons, one called the tilted, and the other the open waggon. The tilted waggon weighs 5 tons 13, the open waggon 4 tons 19; the limit of the load is 6 tons. On the Narrow Gauge, taking the average, you cannot make a precise comparison there again, because the waggons are not constructed in the same way; but taking the average of six ordinary goods waggons on different lines, you find that they weigh 2 tons 12, and their limit as to weight is 4½ tons. Mr. Wyndham Harding.

4477. That is the weight of goods?

Yes, the weight of goods; but it is necessary to remark, that those weights do not indicate at all what the trucks have actually got to carry; in practice the loading of a truck is more frequently regulated by the destination and quality of the goods, than by the absolute weight of the goods, and we find that the result of large trucks of these peculiar dimensions is, that we have a most enormous quantity of tare or unprofitable weight, compared to the profitable weight, as between the one Gauge and the other. I have with me an account of the trains for the last week, which I took accidentally. The traffic at the Gloucester station may be divided into two sorts, terminal traffic and roadside traffic; of course, with regard to roadside traffic, the proportion of dead weight, as compared to net weight, is much greater than with terminal traffic. Between Bristol and Birmingham, last week, we took 219 tons of goods, which were transferred at Gloucester from the Wide into the Narrow Gauge waggons; they occupied, in the Narrow Gauge, 65 waggons, which weighed 169 tons tare; the same 219 tons of goods occupied, upon the Broad Gauge, 48 waggons, which weighed 228 tons; therefore the proportion of useful weight, as compared to the useless or dead weight, is 35 per cent. in favour of the Narrow Gauge. That is an experiment made under the most unfavourable circumstances Weight of goods and dead weight.

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for the Narrow Gauge, for I have put the weight of the Narrow Gauge carriages at more than they really weigh, because accidentally some very light and bad carriages got in among them, and I threw them out, and called them each of the usual weight; but even making those allowances, it is 35 per cent. in favour of the Narrow Gauge, and I think that is the fair result.

4478. Why are the goods more thrown together between Gloucester and Birmingham?

Unprofitable weight in large waggons.

The waggons are extremely large; we feel that we have this great unprofitable weight to contend with, and we put as much as possible upon a waggon when it is not judicious or prudent, perhaps, to do so. On that experiment I would remark, that we had, with less tare, 65 waggons Narrow Gauge, as compared with 48 Broad Gauge; we therefore had a greater area in those 65 waggons than they had in the 48: we had also the loads much more conveniently distributed, because we had it in 65 parts, just as we could wish, instead of in 48, which was not as we could wish.

4479. To what do you ascribe the great increase of weight?

The waggons themselves are heavier, as a matter of fact, and the proportion of unprofitable weight greater, when you compare them with the limit of weight which they may carry, or the limit of bulk which they may carry, it must be so, because when you increase the width of the vehicles, you must increase all their dimensions, you must make them much stronger, and the whole thing is, in fact, a heavier vehicle.

4480. Heavier in proportion to its stowage?

Heavier in proportion to its stowage, heavier in proportion to the weight it may carry, and heavier in proportion to its actual strength; its weight is increasing in a more rapid ratio than its useful dimensions.

4481. I would not give these last figures as an average result, but there is a great difference in the tare

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between the two sorts of stock; and I may say that this difference of tare comes in at all points of the comparison with regard to safety, speed, and power; the dead weight affects the useful result prejudicially.

4489. I do not think it would give a fair test; but I think, with regard to the instance I have given relating to the proportion of tare to net weight, it is one simply of loading out of one waggon into another, and the gross amount of the traffic which the line has in a year has nothing to do with it; it is as good a case as the Great Western or any other line would afford.

4490. One point which I omitted to mention was in respect to the cattle waggons; they weigh, on the Bristol and Gloucester, 4 tons 19 cwt., and carry 7 fat beasts. On the Narrow Gauge lines they weigh 3 tons 10 cwt., and carry 6 fat beasts. It is not merely the locomotive power which is affected by it, but the rapidity and economy of working the stations; applying those results to which I have arrived, you have an advantage of 35 per cent. of profitable weight on the Narrow Gauge as compared with the Broad Gauge. In regard to the traffic upon the Manchester and Leeds, where they have 10,000 tons of goods net per week, it would cause them not only to convey by locomotive power, but to adopt station arrangements, in regard to 200,000 tons a year unnecessarily, which would of course indicate a great expense, and a great amount of delay and annoyance, inconvenience, and obstruction.

Dead weight of Broad Gauge would destroy trade on Manchester and Leeds line.

4491. What was the power used in each case of the two trains upon which you made the experiments where the same goods were carried?

That was the week's work; I thought it not fair to take one train, but the traffic of the week.

4608. On the London and Birmingham line, as nearly as I can make it out, 86 is the average number of passengers in a train, and on the Great Western about 40. I do not pretend that that is precisely accurate.

Mr. Wood. Proportionate length of Gauge.

4548. Do you happen to know the relative proportion between the Broad Gauge lines already completed, or in progress, and the Narrow Gauge?

The Narrow Gauge completed were in June last (I have not the measurement since that) 1844 miles; in progress, 614. The Broad Gauge completed were 278 miles: in progress, 52.

Opinions on Gauge.

4549. Are you disposed to admit such material advantages to the Broad Gauge in any respect, as to think it desirable, for the sake of uniformity, to adopt the Broad Gauge upon the Narrow Gauge lines, supposing it to be practicable?

I have endeavoured to look at the thing without prejudice, and I confess I cannot see the advantages of the Broad Gauge as respects any description of traffic. Indeed, if I were offered two railways to-morrow equally well constructed for the same district of country, *cæteris paribus* in fact, the one a Broad Gauge, the other a Narrow Gauge, I should take the Narrow Gauge as better adapted to the general purposes to which railways are applicable. I think that the Broad Gauge has entirely failed to carry out the anticipations of its projectors. I think if you refer to the passages which I have looked out, in which Mr. Brunel states the ideas which he had in view when he established the Broad Gauge, it will be seen that in every particular those views have not been verified.

Thinks the Broad Gauge has failed to carry out.

4550. Will you read the parts in question?

Mr. Wood says, and Mr. Brunel confirms what Mr. Wood says at page 6 of his Report, "Mechanical advan-
"tage of increasing the diameter of the wheels without
"raising the bodies of the carriages. This comprehends
"what is deemed by Mr. Brunel the most important
"part of the advantage of an enlarged width of Gauge,
"viz., the reduction of friction by the increased dia-
"meter of the wheels, by which, at the same time, by
"being enabled to place the body of the carriage within

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Mr. Brunel's original ideas.

"the wheels, the centre of gravity of the carriage is "kept low, and greater stability and steadiness of motion "is expected to be attained. Four feet wheels have "been put upon the carriages at present in use upon the "line;" but Mr. Brunel states, "that he looks forward "to the employment of wheels of a larger diameter, and "that he has been influenced to a considerable extent in "recommending the increased width by its capabilities of "prospective improvements which may take place in the "system of railroads." He states, that though there are some causes which in practice slightly influence the result, yet, practically, the resistance from friction will be diminished exactly in the same ratio that the diameter of the wheels is increased. And "considering that the "gradient of 4 feet per mile only presents a resistance of "less than 2 lbs. per ton, and that the friction of the car- "riages on ordinary railways amounts to 8 or 9 lbs. per "ton, being 8-10ths of the entire resistance, any diminu- "tion of the friction operates with considerably more effect "upon a road with favourable, than one with more unfa- "vourable gradients." And he further says, "I am not "by any means at present prepared to recommend any "particular size of wheels, or even any increase of the "present dimensions. I believe they will be materially "increased; but my great object would be, in every possi- "ble way, to render each part capable of improvement, "and to remove what appears an obstacle to any great "progress in such a very important point as the diameter "of the wheels upon which the resistance which governs "the cost of transport, and the speed that may be ob- "tained so materially depends."

4551. Is that an extract from something written by Mr. Brunel?

Yes; it is an extract from Mr. Wood, who quotes Mr. Brunel. Mr. Brunel himself confirms this view. At page 15 in Mr. Brunel's Second Report, he says— "On the subject of the 7 feet Gauge, I can add very "little to what I have said before; it was adopted "expressly to enable us to effect that arrangement "which is recommended at page 76." And then he

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quotes from himself—"We see that there is a diminu-
"tion of friction by the increase of the diameter of the
"wheels; but it is doubtful to what extent this is
"modified by elevating the bodies of the carriages and
"consequently diminish the area of the frontage, is an
"advantage considering the great amount of resistance
"arising from the atmosphere. To effect this with the
"most convenient form of body similar to that ordinarily
"adopted on railways, does require, as I have fre-
"quently stated in previous reports, a width of at least
"6 feet 10 inches." That appears to be the prominent object, according to Mr. Brunel's views of the width of Gauge; now has that been realised? The carriages are not placed within the wheels: I think hardly a single carriage upon the Great Western has been placed within the wheels; the diameter of the wheels has not been increased but reduced in the new stock to 3 feet 6 inches. The Bristol and Gloucester wheels are 3 feet 6 inches. In this respect, then, it is clear that the anticipations of the advocates of the Broad Gauge have not been realised.

Mr. Brunel's original ideas not realised.

4559. That is a question of detail and not a question of Gauge.

General principle on which Broad Gauge has failed.

No; that is a question of detail entirely. But the general principle which is stated here, is the general principle on which the Broad Gauge has, in my opinion, failed. These are Mr. Brunel's opinions in page 17 of his Report, in which he quotes from his former Report. "I take it for granted that, in determining the dimen-
"sions in each case, due regard has been had to the
"curves and gradients of the line which ought to form
"a most essential, if not the principal, condition. In
"the Report of the Commissioners upon Irish Railways,
"the arguments are identically the same with those
"which I used when first addressing you on the subject
"in my Report of October, 1835. The mechanical
"advantage to be gained by increasing the diameter of
"the carriage wheels is pointed out; the necessity to
"attain this of increasing the width of way; the
"dimensions of the bridges, tunnels, and other principal

"works not being materially affected by this; but, on "the other hand, the circumstances which limit this "increase, being the curves on the line, and the in- "creased proportional resistance on inclinations (and, "on this account, it is stated to be almost solely appli- "cable to very level lines); and, lastly, the increased "expense, which would be justified only by a great "traffic. The whole is clearly argued, in a general "point of view, and then applied to the particular case, "and the result of this application is the recommenda- "tion of the adoption of 6 feet 2 inches on the Irish "railways. Thus an increase in the breadth of way to "attain one particular object, viz., the capability of "increasing the diameter of the carriage wheels, with- "out raising the body of the carriages, is admitted to "be most desirable, but it is limited by certain circum- "stances, namely, the gradients and curves of the line, "and the extent of traffic. Every argument here "adduced, and every calculation made, would tend to "the adoption of about 7 feet on the Great Western "railway." Those are the views which Mr. Brunel adopts and puts forward as his own. Now, I think that the necessary conditions, as stated there for the Broad Gauge, were a level line, and easy curves; those conditions are entirely departed from in the extensions of the Great Western. The Bristol and Gloucester line, the Bristol and Exeter line, and the Cheltenham line, present bad gradients, and very sharp curves. It is, therefore, clear that the Broad Gauge is not applicable to those lines on Mr. Brunel's doctrine.

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Broad Gauge not adapted to Bristol, Exeter, and Cheltenham lines.

4562. I imagine those are rather objections which Mr. Brunel is stating to his own principle, which objections have not been found to exist in practice?

I think not; I think he justified the adoption of the Wider Gauge, because, he said, that as the conditions varied, the Gauge should vary to suit those conditions, and that certain conditions were suited to the Wide Gauge; now, these conditions have been found generally impracticable, as you cannot, for economical reasons, establish those good gradients and good curves. Upon

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those principles, then, the Broad Gauge is not applicable to those lines now existing.

Opinions on Gauge.

4563. What do you imagine the want of success consists in?

I mean to say that it was brought forward on certain views, and supported by certain arguments, to attain certain objects by certain means; that it has been found that those conditions under which it was brought forward, cannot be complied with in the extension of the system; that the objects are not attained, and the means by which those objects were sought to be attained are relinquished. From this I argue that the theoretical views on which it was based have been found to be erroneous.

Mr. Brunel's theoretical views proved to be erroneous.

4570. I do not see how an expensive innovation, such as the Broad Gauge, can be justified, except by decided success. That decided success, in my opinion, facts do not prove to be attained in any respect.

Thinks Narrow Gauge has the advantage in safety, economy, gradients, curves, convenience.

4580. That is so far as speed is concerned. As far as safety is concerned, I think there is no practical difference; but abstractedly there does seem some reason for there being less safety on the Broad Gauge than on the Narrow. As far as economy is concerned, I am convinced that if economy is measured, as I think it should be, by useful effect, the economy will be found, even disregarding the advantage of gradients and curves possessed by the Great Western, to be decidedly on the side of the Narrow Gauge lines. And as regards convenience, and the general adaptation of the railway to the purposes of traffic in passengers, (four-fifths of which, it must be remembered, consist at present, and nine-tenths will not improbably soon consist, of second and third class passengers,) and of the traffic in goods, for which railway conveyance is found to be as valuable as for passengers, I think that as regards the general adaptation of the railway to those purposes, the Narrow Gauge is found to be the more convenient. I may be utterly wrong in the last part of my evidence, and very likely am, but I have stated my impressions, and I base these impressions on this: that being ac-

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quainted with the views of many engineers, at the time of the introduction of the Broad Gauge, I know their opinions were to this effect,—that the great resistances to be contended against on railways were the surface resistances, as they may be termed; that is, the resistance to the turning of the wheel from friction at the axle and periphery, and the resistance from gravity; that if you could only overcome these by large wheels and flat gradients, there was no limit to your speed, and no reason why you should not go at 100 miles an hour as well as 50. It was not then generally known or recognised, that the contingent resistances, called atmospheric resistances, increased in the enormously rapid ratio as compared with the velocity, which is found to be the case. That seems to have been the error of Mr. Brunel, and of almost all engineers at that time; and it accounts, in a great measure, in my opinion, for the Broad Gauge not having succeeded decidedly; it is founded on an erroneous theory.

Atmospheric resistance not calculated in theory of Broad Gauge.

Theory of Broad Gauge explained.

5306. If you will permit me, I do not think I made myself very clear on the subject of the theory of the Broad Gauge; if you will allow me to state generally what it is that I wish to be inferred from what I stated; it was this, that the Broad Gauge was established on certain theoretical principles, based on doctrines of resistances to trains, which doctrines are clearly laid down in Mr. Brunel's reports; that according to these principles, it was an essential condition to the claim of the Broad to superiority, that it should be accompanied by very easy curves and gradients of very light inclination; and that it has been found expedient to relinquish the particular arrangement of wheels and of carriages, which it was considered essential to adopt; and, therefore, I conclude from this, that either the theory on which it was based has been found to be an erroneous one, or that the Broad Gauge is now introduced under conditions which are not suitable to it; one of those two conclusions I think must follow. I think it is also capable of demonstration now, that the doctrine of resistances which prevailed when the Gauge was first thought of does not accord with facts; and I think this

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[illegible] remark in explaining why, according to my view, no appreciable advantages have resulted from an experiment which was very expensive, and which seemed at first sight to offer a railway of greater capacity than the less expensive form of railway: and I think this also leads to the inference that, in looking forward to perfecting the railway system, that arrangement which has been found to be based on the erroneous theory is not likely to lead to further improvements. That is the general tendency which I wished to give to my remarks.

5310. I cannot say that I could ever find a palpable reason for increasing the 4 feet 8½: the reason which the engine builders have given does not seem to me to be of much weight; because many of them have told me that it caused some difficulty at first, but that they could not say that there was any difficulty now: it is merely for a degree of convenience which you cannot regard in a question of this sort.

5312. I have not Mr. Brunel's Report with me, but the Commissioners will perhaps remember that the doctrine of districts is laid down very clearly in that Report, that it is proper and fair to assign a certain district of the country to a certain railway company by a certain arrangement; now I think that that doctrine is not a tenable one.

Experience shows Mr. Brunel's opinions to be erroneous.

5313. I think that experience shows these views to have been quite fallacious, and the conduct of the Great Western Company itself shows it, so that I think the Narrow Gauge promoters may now fairly say that we warned you, the Broad Gauge advocates, of all these evils that seem likely to arise now. We foresaw that the Broad Gauge, as a mechanical arrangement, would not give you compensating advantages which you said would result; and it is now for you, who have given rise to these evils, to apply a remedy to them, or, at all events, not to stand in the way of a remedy being applied.

5311. I would remark on another feature of the railway system, which is just appearing now, viz., the

Mr. Wyndham Harding.

Conversion of canals to railways.

conversion of canals into railways. The tendency of that will be to throw an enormous quantity of goods upon railways, and to make the adaptation of any particular form of railway for the conveyance of goods a matter of greater importance than it has hitherto been considered. And another tendency of the railway system at present is, I think, to subdivide the traffic into a great many channels. We have now a parallel line coming before Parliament next year, proposed by the London and Birmingham, itself to itself; and even the Great Western has a parallel line proposed by itself to itself; and I think the result of this must be to diminish the traffic in any one particular channel, and divide it amongst many; that has perhaps some bearing on the question, as some doubt has arisen as to whether you can carry large masses at once better on one Gauge than on the other.

Tendency in railway traffic to subdivision.

Mr. G. Hudson.

Nov. 22, 1845.

GEORGE HUDSON, ESQ., M.P.*

Opinions on Gauge.

6360. Have you, in the course of your management or direction of the railways of which you are Director, seen much cause to regret that they are upon the Narrow Gauge?

No; without any prejudice in favour of either the Broad or Narrow Gauge, I am perfectly satisfied that every thing is accomplished by the narrow that is accomplished by the broad; and therefore, as economy in the construction of Railways is an important element, the Narrow Gauge, I should say, was the better of the two.

6369. Have you any opinion as to the greater or less convenience of the narrow or broad Gauge waggons for commercial purposes?

I think there cannot be a doubt that either waggon is equally convenient for packing; the packs, so far as I have seen in my experience, are never of such a width as not to admit of being loaded on the Narrow Gauge, and if they can be loaded conveniently upon the Narrow Gauge, of course they can be loaded equally conveniently upon the Broad Gauge. I prefer the Narrow Gauge on account of the greater economy of construction. Looking at it in the most dispassionate way possible, I much prefer the Narrow Gauge, unless it is shown me that there is any great advantage obtained by the broad, with which I am not yet conversant. I

Prefers Narrow Gauge on account of economy of construction.

* 6358. Can you state what is the number of miles of Railway over which you are a Director?—It must be from 800 to 1000.

Mr. G. Hudson.

think, in regard to weight, we can certainly carry as large a quantity by the Narrow Gauge by one train, as can be carried by the Broad Gauge.

Can carry as large a quantity by Narrow as by Broad Gauge train.

6367. Have you at all contemplated the inconveniences that are likely to arise from a break of Gauge?

I think the public can scarcely overrate the inconvenience; with reference to goods it is exceedingly expensive and injurious: for instance, suppose a case were to occur that we had a change of Gauge between Manchester and Hull, and we had to move the packs from truck to truck, if it were to be done by that system (and if not any other system would be expensive), I believe that very few packs would come upon the line, for every movement of a ton of goods is a derangement of the packing, and is looked upon by the exporter as an inconvenience. I do not think it is possible to overrate the inconvenience that is experienced from the trans-shipment of goods from Birmingham to Bristol. It crowds up the station, and the unpacking and repacking of goods is most injurious. As I have already said, if such a change were to take place between Manchester and Hull, virtually we should carry nothing; the goods would go by water to a large extent.

A change of Gauge between Manchester and Hull would destroy goods traffic on that line.

6384. What is the length of line from Birmingham to Gloucester?

Thirty-seven miles.

6385. If instead of thirty-seven miles the distance were one hundred, should you not be disposed to overcome the evil of trans-shipment, rather than change the Gauge?

If, from our having two Gauges, trans-shipment is to take place at all, the thing is to consider where the least export takes place.

6388. To show the amount of traffic we are contemplating may come upon the Midland line, we have it under consideration to order 10,000 coal waggons.

Contemplate ordering 10,000 coal waggons.

Mr. G. Hudson.

6389. Such being the case, do you apprehend any great inconvenience would arise from your having part or a great part of them, made upon the loose box system?

Loose boxes would require double frame-work.

The inconvenience would be this, that you would have double frame-work, which is nearly one-third of the total expense; that it is a loss of capital and inconvenience.

6414. Do you think that, upon general principles, it would be better to have a change of Gauge under the control of the same company, rather than have two companies, other things being the same?

Yes; that they both should be under the same management would be an advantage.

6415. It applies at present to Gloucester; they are both under one management there?

Yes; so satisfied are we of the inconvenience of it, that we are quite prepared to lay out money to remedy that inconvenience.

6416. You shift it on to Bristol?

Yes, to a certain extent; but my principle is this, that there is less trans-shipment at Bristol than there is at Gloucester. If they could show me that there was a greater amount of trans-shipment at Bristol than at Gloucester, my argument would not hold good.

Speed and safety.

6365. I am not aware that we are not competent to attain the speed of the Great Western; whether it is wise to adopt that speed is very doubtful to me. There is a point to which the speed may be carried which becomes dangerous. We are constantly running from Normanton in thirty-seven minutes—forty-nine miles an hour—but we are not limited; we limit our trains to what we think safe and advantageous; I think we could travel much more quickly.

There is a point at which speed becomes dangerous.

Mr. G. Hudson.

Convenience.

6366. And you are of opinion that great rivalry of speed between two railways on the Broad and Narrow Gauge may lead to disastrous consequences?

Certainly. I think there is also great convenience with the Narrow Gauge in working the traffic, by our carriages moving from point to point, or trucks of goods moving from the different points on the line. I saw an instance of the inconvenience of the Wide Gauge when I was at Bristol the other day. Our trucks will hold generally from four to six tons, never exceeding six. One horse will turn and move that truck with perfect ease. I inquired particularly the weight of the trucks on the Great Western; they are thirteen tons, and that becomes exceedingly inconvenient for one horse to move; it was distressing to me to see them move them, and there would be great difficulty in attaching a second horse to assist. That was a practical illustration, that unless you could gain something by the Broad Gauge, the present Gauge was wisely chosen.

One horse can move 4 to 6 tons, the weight of a Narrow truck, but scarcely 13 tons' weight of Broad Gauge truck.

Captain M. Huish.

Nov. 28, 1845.

CAPTAIN M. HUISH, General Manager of the Grand Junction and Liverpool and Manchester.

Comparison of the Gauges.

4629. Do you find any practical inconvenience from the width of the Grand Junction, the line you have been connected with being limited to 4 feet 8½ inches?

I have never found any practical inconvenience. I am satisfied that we have, within ourselves, on the Narrow Gauge, the means of accommodating any description or any amount of traffic which may be brought to us, great or small.

Captain M. Smith.

4637. The limit of our load for passenger trains is 80 tons; for goods, 200 tons.

4718. Of course, if you had to use larger waggons, like Broad Gauge waggons, there would be greater loss from tare?

From wear and tear, and tare weight. I feel perfectly satisfied that the development of the Narrow Gauge is not by any means arrived at, and that we have a capacity within ourselves which would almost surprise the public if we attempted to go to the extreme point which we might do with safety and practical utility.

4719. We were about to inquire whether you were prepared to give a decided superiority to one Gauge over the other, or whether you thought there was so near an equality that there was no reason for the more costly construction of the Broad Gauge?

I was asked the same question last session in committee, when, under peculiar circumstances*, if I had any tendency, it would have been towards the Broad Gauge, and I recollect my answer was, that if I had to choose between the two, I was afraid I should give it in favour of the Narrow Gauge. Having stated that last session, I have seen nothing whatever to alter my opinion at present.

Break of Gauge.

4727. Assuming that the transference of goods at Birmingham is as 920, at Gloucester 685, and at Bristol fifty-one tons only, where do you think the change of Gauge should take place, that

* The Grand Junction had not then amalgamated with, but was hostile to the London and Birmingham, and was supporting the Great Western Company in the contest about the Oxford, Worcester, and Wolverhampton Railway Bill.

transference relating to the Birmingham, Gloucester, and Bristol line?

At Bristol, where instead of having those 920 tons, you would have got rid of all that work which you would have had to do at Birmingham without a change of Gauge, by the thing doing itself.

Convenience.

4630. Do you find that the passengers complain of uneasiness in the carriages, which they do not complain of on the Great Western?

I think that our line and the London and Birmingham can convey a passenger as smoothly as it is possible for him to be conveyed upon parallel iron bars.

4631. The public always select the carriages in which there are only two seats abreast, if they have the option, which is the construction of the old mail.

4634. You think that placing four passengers abreast would not produce such an objection on their part as to induce them to take another route where they had carriages three abreast?

I cannot think that it would weigh to that extent, but it does weigh to some extent. The Great Western practically admit it, inasmuch as they divide their every compartment itself into two by a partition in the centre.

Construction—Curves—Speed.

4624. Have you any outside cylinders upon the Grand Junction line?

We build nothing else now—have done so for the last two years. Some four years ago we were continually breaking our crank axles, partly in consequence of the material not being so well wrought as it is now, but also in a great measure by the extreme severity of some of our curves, particularly the one by which we go into the Liverpool and Manchester. We

Captain M. Huish.

broke them there, and that was the first cause of the outside cylinder and straight axles being used. The regulation of the Company is, that they shall go round that curve at five miles an hour; but an engine-driver hardly knows what that means.

4655. Safety, of course, is but a comparative term, and there must be a point at which comparative safety ends and positive danger begins. I should have no hesitation to-morrow in recommending the Board to diminish the time of the journey between London and Liverpool. We could do it, in my opinion, with safety to the public and with perfect ease to ourselves; but seeing the excitement in the public mind, I do not think it would be by any means politic to encourage it at present, until the public is accustomed to it, a higher speed than that at which we are now travelling. At the same time I should be sorry that the Commission should imagine that what we call our express speed is at all that speed at which we think the engine is fully tasked.

Believes that pace of trains between London and Liverpool could easily and safely be increased.

4658. As far as regards the permanent way, as to the surface of the line, I should not be afraid to trust myself at all (that is the best test I can give) at 60 miles an hour, but there are other elements which necessarily come in as connected with the public safety. The very fact of our having now trains of such very different velocities, and the line from London to Liverpool being worked as one line, practically renders it necessary that the slow trains should *shrink* at particular places to let the express pass; and of course any dislocation of the system there, where trains are timed to a nicety, must either cause great inconvenience to the public by keeping them a long time at particular stations, or some risk.

Express trains compel other trains to halt and stand aside to let them pass.

Captain J. M. Laws.

Aug. 26, 1845.

CAPTAIN J. M. LAWS, R.N., General Manager of the Manchester and Leeds Railway, Director of the London and York, Wakefield and Goole, and the Leeds and West Riding.

1663. Have you any experience of the Great Western or other Broad Gauge lines? **History of Gauge.**

I have been on the Great Western several times, and my attention was particularly directed to the question of the difference of Gauge at the time Mr. Brunel first proposed it, and the reasons of his adopting so wide a Gauge as 7 feet were a very notorious thing at the time, and certainly the reasons he gave for adopting it have been abandoned by him. One reason for his adopting it, given at the time, was that the great difficulty would be in getting a sufficiently rapid motion in a piston to revolve the wheels quick enough to get a very high speed. He said we must obviate that by having larger driving wheels: he then proposed to have 10 feet driving wheels. Then 10 feet driving wheels upon a Narrow Gauge would have thrown the centre of gravity in the engine too high, and it was considered that it would not have been safe, and accordingly he increased the width of the rails to 7 feet, which would bring the centre of gravity comparatively about the same as the others, with a 5 feet wheel on a 4 feet 8½ Gauge. This having been adopted for the express purpose of supporting the high wheels and attaining speed by their great diameter. It was found, however, that the wheels were almost impracticable; that there was great difficulty in getting the engine into motion with them; and when in motion, there was difficulty in stopping her. They have to a certain degree abandoned the high wheels, and they find they have no difficulty whatever in getting all the rapidity they want in the piston to work with smaller wheels, and to attain as high a speed as they ever

Mr. Brunel's reason for adopting Broad Gauges.

10 feet wheels abandoned.

Captain J. M. Laws.

contemplated with a larger wheel. Mr. Hawkeshaw, our engineer, who is now in Scotland, or he would have come up, I know was called upon to report by a section of the proprietors of the Great Western Company, when the line was partly made, as to the prudence of the abandonment of the Wide Gauge altogether, and adopting the Narrow Gauge on the Great Western. He made a Report (I should think, about seven years ago). That Report is in existence in the "Railway Times:" but he was then a very young man, and it was thought presumptuous in so young a man being called upon to make a Report upon the plan of a person who was supposed to have more experience: that Report very emphatically recommended them to abandon the Broad Gauge and adopt the Narrow one, and he gave, I think, very cogent reasons why it should have been done at that time.

Break of Gauge.

1715. Have you at all contemplated what would be the inconvenience to the Manchester and Leeds Company, if the North Midland were to change their Gauge?

The result of it would be, we should try very hard, if there was any considerable traffic between us, to get another line upon the Narrow Gauge. We should immediately attempt that, because we could not alter our Gauge with the tunnels and viaducts that we have; it would be almost as cheap to make a new line as to alter the Gauge. I can contemplate no practical means of moving goods in loose boxes. One part of our waggon would be in one part of the world, and another part in another; and there would be such confusion and mixture unless the railways were all one property,—and, even then, you would find boxes at one end of the line when you wanted them at another; you would find one end of the railway with a great many more wheels than they wanted, and another with all the boxes.

Almost as cheap to make a new line as to alter existing Gauge, in consequence of new tunnels. With loose boxes confusion would result from one part of waggon being separated from another.

1725. Must not that arise from some want of system? I cannot understand how we are to move the load. As to the mere mechanical process of moving an engine or a waggon from one point to another, no doubt a mechanical arrangement could be made to move an engine 30 feet high in a few minutes; but to say that to divide the waggon, and that one part of the waggon is to be left here and another to be left there, I do not think any arrangement could be made that would not prove a vast inconvenience.

Captain J. M. Laws.

Remedies.

1726. Supposing the Railway Company furnished the under carriage, and the proprietor of the goods furnished the box to contain those goods, he would then bring his goods to your under carriage, and you would accommodate him?

A farmer, for example, brings his two loads of corn in from his farm at Wakefield or Pontefract; I would much rather take his waggon, if he could afford to send it, than have any bother about loading it on to another railway. That man could not undertake to find a railway-box. The same with green-grocers. At this very time we are sending trains from Manchester, containing green-groceries, to the extent of 150 tons a day, going from Manchester along the valley of the Calder. Those gardeners would never find boxes. These waggons go on with the green-groceries, and bring back corn; so that if we were to make a change of Gauge on that journey, every article would have to be changed into another carriage by hand. The best way to change it would be by hand, much better than attempting to change the bodies of the waggons; and I am satisfied that very great risk would necessarily be involved by changing any of those waggons in the night. For instance, nearly all our goods trains meet at Normanton in the night. We often have as many as 300 waggons of goods at Normanton for different parts of the district,—some coming to Manchester, others going to Leeds, others to Hull; they are all put into the Normanton station at night. It is with the greatest diffi-

150 tons of green-groceries from Manchester daily, and return with corn.

Three hundred waggons at Normanton at night for Leeds, Manchester, and Hull; trans-shipment would cause immense delay, expense, and danger.

Captain J. M. Laws.

culty, with the aid of torches, that it is done. The wonder is, how they get on without danger now; and if you had to trans-ship all those goods from one waggon to another, or from one bottom of a waggon to another, it is palpable that it could not be done without an immense amount of delay, expense, and danger. If those things were done in the night, you could not depend upon the man having placed the boxes securely on the bottom of the truck. The first thing I should expect to hear would be, that some of them had bolted off the bottom of the framing, and upset the train.

1728. Do not you think that, by having your empty goods waggons properly marshalled on one line, and bringing up a train full of goods abreast of them, the goods might be shifted, carriage by carriage, in an hour by machinery, and dropped into the under carriages?

Delay of nine or ten hours in a dark winter's night.

I will just take a winter night in our northern climate as we have it,—a dark, snowy, or rainy night. We are often three hours now in sorting our waggons, with three or four locomotive engines to assist. If we have to move our waggons by hand at Normanton, where there are four diverging lines, it would take us nine or ten hours in a dark winter's night. I cannot contemplate getting over such a difficulty. To do it by moving one waggon from one body to another would be attended with vast expense, inconvenience, and danger. You must have a station three times as large as it now is; and goods that are now shipped down at Hull in the morning, will, in all probability, be there in the middle of the next day.

1734. Supposing the loose-box system should be determined upon, will you state how you think it could be carried out?

I am unable to state.

1735. Do you think the system of running the Narrow

Captain J. M. Laws.

Disapproves of placing Narrow Gauge carriages on Broad Gauge trucks.

Gauge carriages upon Broad Gauge trucks would answer?

No, I do not.

1736. Why not?

I think the plan of dividing a truck into two parts would be attended with such great practical inconvenience as to make it wholly inapplicable; and I would much rather move the goods at once from one waggon into another, than attempt to enter into such a system; and if the system were to be set afloat immediately, and they were now to have to provide their trucks and to move their goods, I have no doubt, from the practical working of railways now in existence, it would dwindle down in twelve months to having none of those, and that they would say we had better move the goods at once by hand.

1737. The loose-box system would involve a considerable increase of expense to your Company?

Yes, if we had to bear our proportion; but we should not do it.

1738. Have you at all thought of what cost it would involve to cancel all your goods waggons, and to adopt others upon the loose-box system?

The value of our goods waggons now is about 48,000*l*. Then, if we were to adopt this loose-box system after all, the Broad Gauge must be entirely limited to the accommodation of the Narrow; they could have no wider box than we could carry.

1746. Did you examine the system of working of the joint station at Gloucester with regard to the change of Gauge?

Yes; there is not a large goods traffic, but there is great inconvenience. In fact, the inconvenience that is now experienced at Bristol from the wretched arrange-

Captain J. M. Laws.

ments of the station is almost as bad as at Birmingham, except for certain trains, as regards passengers. The folly of the two stations being arranged as they are at Birmingham, of course, may be easily remedied, and will be when they can get some other railways that will work them a little close; they will have to give up the existing arrangements. The London and Birmingham arrangements at Birmingham involve as much delay and inconvenience as the Gloucester system does.

Example.

I went on Thursday last from Gloucester to Manchester. Of course, we had no change till we got to Birmingham. When we arrived at the London and Birmingham station, and were going to Manchester, the London and Birmingham servants had not the slightest interest in us. We arrived by the Gloucester Railway, and were going by the Grand Junction. We saw an express-train engine just coming in to the station to take them as we got in. We were very anxious to get on by that train. "No, you are too late for that train," was the reply. Then we wanted to get our luggage over. "It will go over by-and-by in a truck." There was all the inconvenience of getting the luggage moved across in a truck, and the risk of leaving something behind. We did get it over, but not with less inconvenience than if we had to change the Gauge. But that is an evil that clearly ought to be remedied, and can and must be remedied by the two Companies before long. It was a great absurdity for the two stations being formed like termini stations, instead of making Birmingham like a road-side station, so that both Companies could have run through without this moving of carriages. That arose out of the squabbling and misunderstanding of those two Companies. If they make the London and York Railway, there will be nothing of the sort. You will have no change of carriage till you get to Newcastle or Edinburgh. But the station at Derby is just as bad. In the station at Bristol they have adopted the same course as at Birmingham, and nothing can be more inconvenient, or cause more delay.

Captain J. M. Laws.

1747. They have the same sort of inconvenience that you contemplate in a change of Gauge?

The same inconvenience must be involved in every change of Gauge, but at present that has not been sufficiently appreciated, because the Narrow Gauge lines at this moment, from bad arrangements, are submitting to a very great proportion of the same inconvenience as regards passengers. I was very much struck at the difference between those stations and the Victoria station at Manchester. In that station we have nearly eighty trains a day in and out at the two ends, and I will be bound to say that we have not above one-third of the porters that there are at Bristol, or that there are at Birmingham, although we have double the number of passengers in and out that station that there are either at Bristol or Birmingham—I believe equal to the two put together—and there is not one-quarter the inconvenience. The train goes right through, and if you have a change of carriage they just cross the turn-plate; and two men can do it in two minutes, and the cost of that station is not one-third what either of the others was in construction or working.

Eighty trains daily at Victoria station, Manchester; one-third less porters than at Bristol.

Opinions on Gauge.

1751. You are aware that an Act has been passed in the late session for a line of railway between Rugby and Oxford; and that the question is undecided what Gauge shall be used on that line?

Yes; I was not aware how that question stood, but I am sure that if Oxfordshire is to be supplied with coals at a cheap rate, and that cheap rate and that supply of coals is to be made available as soon as the line is made, the Narrow Gauge will be the best means of securing it. A supply will be opened close to Rugby, and a district that is now very badly supplied, judging from the price, will then become as well supplied almost as any part of England, and the produce of that agricultural district would be taken back to the manufacturing districts with great despatch and cheapness, in proportion to what it is now. We have, at this

Oxfordshire ill supplied with coals.

Captain J. M. Laws.

moment, flour and malt ground and made in the neighbourhood of Newport Pagnell, not far from that district; and the process of getting it to Manchester is this:—it drops down the Lesser Ouse all the way to Lynn; from Lynn it is put into ships and brought to Hull; and from Hull it is brought on our railway to Manchester. In sending by canal, it is often a fortnight or more getting from there to Manchester. If a Narrow Gauge Railway were made there, they would send minerals down direct, and return corn and fruit; they get a great deal of fruit in that district, and other garden stuff, particularly cucumbers. I have seen as many as four railway waggons coming from the neighbourhood of Rugby, full of cucumbers, to Manchester; about 12 or 14 tons of cucumbers. If there was a change of Gauge there, this would be attended with expense and inconvenience. We should say, "Oh! we cannot allow our waggons to go about without tops and bottoms." Whatever you do, whatever you may fix, upon the subject of Gauge, the Gauge must ultimately become uniform, if we intend to communicate readily with each other. Whether the 4 ft. 8½ in. is the best Gauge or not I do not pretend to say. It is a very good one, and we have found no practical inconvenience in it of any kind. I know of no difficulty that has been demonstrated in it, but I have no doubt that anything between 5 ft. and 5 ft. 6 in. would be a very good Gauge. But the wider you get, the more limited you are in the use of that Gauge in a broken country, as is demonstrated by the collieries, most of them having a very much narrower Gauge than 4 ft. 8½ in., and they have adopted it because it was cheaper, and better adapted to get round the sharp curves. A small outlay in winning determines very much the price of coals; and where it is a question whether it is worth while to open a colliery or not, a wider Gauge than 4 ft. 8½ in. would be entirely useless for any practical purpose.

Minerals would be exchanged for corn and fruit by a Narrow Gauge line.

Rugby sends waggon-loads of cucumbers to Manchester.

The wider the Gauge the more limited the use in a broken country.

1753. It seems to be quite clear that the Narrow Gauge of 4 feet 8½ inches was adopted for

very sharp curves in the collieries, but as such sharp curves are not used on railways, is not the necessity for that Gauge of 4 feet 8½ inches diminished, if not altogether obviated ? Captain J. M. Laws.

I do not apprehend of necessity so, because the great wealth of this nation, the great internal resources of this country, depend on its minerals : a bag of coals would not be so comfortable a thing for the Lord Chancellor to sit on as the woolsack is, but much more emblematical of the wealth of England. It is the coal and not the wool that has made England what it is, and that is yet in its infancy ; and the superiority of this country, either in war or peace, will depend upon its coal and iron. Coal more emblematic than wool of the wealth of England.

1754. You think the resources of this country are not fully developed of either one or the other ? Resources of country not fully developed.

Certainly not, as compared with what they will be; the mineral wealth of this country is just touched on the fringe, something like the cultivation of New South Wales, as compared with what it may be.

1755. And you imagine that the great increase of railway communication will tend to develope those resources ?

More than anything else I can conceive.

1759. We have been told that the trans-shipment of coals from one Gauge to the other would involve, by mechanical operations, an expense of only 1*d.* per ton, either at Rugby or at Oxford. Have you any experience of the cost of moving heavy goods of that description to enable you to test the accuracy of that opinion ? **Remedies for Break.**

No. Of course, that could only be done by the top-and-bottom system, because we know it costs about 3*d.* a ton to move coals from a canal-boat to the wharf. The common price is 3*d.* a ton in almost every district Loss of mechanical trans-shipment

Captain J. M. Laws.

you go to. I can easily understand that that might be done, if the whole thing rested there, at 1*d.* per ton, the mere lifting across; but you have the inconvenience of this divided waggon; you must have two sets of bottoms to effect the same thing. Those bottoms that are left at Rugby, I suppose, would have to remain there until they returned home, or that there would be a change of an empty bottom for a full waggon. That would involve a double number of waggons, besides the labour. Then, I apprehend, making this railway on the Wide Gauge would be something more costly than on the Narrow Gauge, and the whole of the material for making it I look upon as an additional expense involved in the question. I do not measure it by the 1*d.* a ton, but I say the whole material, the engine and all the waggons, would be an additional cost. As to the difference of Gauge, I do not measure it by the 1*d.* a ton, because, practically speaking, the thing would be that these waggons would be standing idle double the time that they would be if they went through in the same bottom, and were discharged at their place of destination.

1760. Does it happen that you send any goods by your railway that eventually reach Oxfordshire?

Quantity of textile goods consumed in purely agricultural countries insignificant—all Oxfordshire not six loads a week. Railways in their infancy.

I have no doubt we do, though we do not declare our goods to other places than London and Birmingham and places along the Midland Line. The Oxford people would get their manufactured goods out of Lancashire and Yorkshire to Leicester; but still the quantity of goods actually consumed in any district is a mere bagatelle, unless you have an export trade; it would never be worth making a truck to move for. I do not suppose the whole county of Oxford would consume six railway waggon loads of textile goods in a week. But look at the coals, look at the iron, look at the stone. When you talk about the comparatively small amount of goods trade on a railway, that is what railways are doing now; but what railways are designed to do is to carry every necessary for the construction of houses or the keeping in repair of farms,

Captain J. M. Laws.

or the produce of farms which they have not yet touched.

1761. How do you account for the railways not being used for those purposes already?

Railway companies in their infancy as yet.

Because Railway Companies are in their infancy, none of them know their business yet, we are only just learning our business. But take timber—Oxfordshire has a great deal of timber in it, and that timber will find a market at the seaports, at the manufacturing districts, and the timber is now rotting in the wood there, because it is not worth moving. How are you to move the timber from those trucks to others? It will cost you more than a penny a ton to move timber. We have a very large trade in timber, we send timber from Liverpool and from Hull, all down this district; we shall send to a much greater degree than it is now sent. We have balks of timber, 60 and 80 feet long, going along the railway, that could not be carried for a penny per ton.

Uniformity.

1756. And you think that any want of uniformity in the Gauge of railways will tend to diminish that development?

Development of mineral resources more important than speed.

Clearly. I look upon the question of transmitting passengers at 60 miles or at 40 miles an hour as nothing in comparison with these hidden resources; 40 miles is quick enough for anything. 50 miles we can go as safely upon the Narrow Gauge as upon the Wide Gauge; but I look upon it as a most important thing for this country, to the best practical means of commercial communication, and that commercial communication depends upon the mines, and not in conveying passengers 60 miles per hour.

1757. Are you of opinion that mineral traffic is sufficient to justify the construction of a railway in

Captain J. W. Lewis.

any district where that mineral traffic would be large, irrespective of passengers altogether?

Yes; I look at the question not so much with regard to passengers as I do with reference to the enormous mineral wealth which is now in fact the basis of this country's manufacturing districts. What should we be without our manufacturing districts? We could not eat our corn or support ourselves. The wealth of the country depends upon its coal and its iron; and wherever you can give facilities for opening the collieries and the mineral districts of the kingdom, you do a vast deal more than by making a railway to travel 60 miles an hour for passengers. We owe all our railways to the collieries in the North; and the difficulties which their industry overcame taught us to make railways and to make locomotives to work them.

1719. Do you think it would be utterly impossible to widen your Gauge upon the Manchester and Leeds?

Utterly impossible. If we altered the Gauge, the tunnels must be altered.

Comparison of the two systems.

1693. Have you any reason to believe that the Narrow Gauge has any advantage over the Broad for goods traffic?

I think the Narrow Gauge has decided advantages over the Broad for goods traffic, inasmuch as you must have very large and unwieldy carriages on the Broad Gauge, or they must be carriages that would be subject to a very unequal motion on the Broad Gauge as compared with the Narrow one; for instance, if there is not a very large carriage it must be nearly a square one on the Broad Gauge. If I attempted to draw a square box by the centre it must partake of any inequality of the road, and have a much more violent motion than if I was drawing a body of a more oblong shape. Some of the carriages on the Broad Gauge are quite as long

Captain J. M. Laws.

in proportion to their breadth as the Narrow Gauge; of course that observation would not apply to a carriage under those circumstances. What I mean to say is this, —the ordinary length of a Narrow Gauge waggon is about 14 feet; (nearly all the Companies have adopted a large sized waggon, about 14 feet long and about 7 feet wide). If you were to take the proportions, say that the length of the waggon is nearly three times the breadth of the points of support, you have a great deal to steady you, and it would not partake so readily of the lateral motion as if the carriage was drawn by the same point of traction and was only half the length. The effect of any little inequality would be to give much more motion to a short waggon than a long one, and that would apply to carriages unless they were equally long in proportion to their breadth, and I believe commonly the Great Western carriages and those upon other lines in connexion with them, are quite as long, if not longer. I observed some of them upon the Bristol and Gloucester last week; they are immensely long carriages, longer in proportion than most of the Narrow Gauge carriages, and I did not observe that there was any very great difference between the motion on the line between Bristol and Gloucester and upon that between Gloucester and Birmingham; but with respect to the coal-waggons I saw on the line, I observed particularly the coal-waggons they were using from Coal Pit Heath Colliery, about six miles out of Bristol, they were not longer than our coal-waggons, nor would they carry very much more; but it is a country that is not very much broken; it is a tolerably level country; you gradually rise out of Bristol; they have no very sharp curves to go round, but if you took the Broad Gauge into another country where the coal-waggons have to go into curves of 100 feet radius, you could not get those coal-waggons round at all.

Could not get Broad Gauge coal-waggons round sharp curves.

1694. You are of opinion that a Broad Gauge carriage is unsuited to a country of great undulation or tortuous lines?

I think more especially in coal traffic. Whenever you

Captain J. M. Laws.

Curves.

get into a coal country, you get into a country that is a good deal broken, and you must have sharper curves to go round to get the waggons to the coal-pits than could be adopted upon the Broad Gauge. The proof is, that the collieries often make their own Gauge 3 feet, for the purpose of getting the waggons round curves which a Wide Gauge could not encounter. And in Scotland you find some of the colliery lines 4 feet Gauge.

1696. If we had a Wide Gauge we must have warehouses and a station of nearly double the cost that we are now building at Manchester. It is a line of building on arches. The trains come in at the top of the warehouse; we bring a train with 100 tons of flour in at a time; and if we had had the Wide Gauge we could not have got round the curves which we pass those waggons round now; we must have had almost double the space. It is constructed on a viaduct, and we avail ourselves of that circumstance, which is generally considered objectionable, and have made it of very great advantage, inasmuch as the load is always descending. The flour comes to the top of an inclined plane, and with little or no labour it is slid into the warehouse and cart that takes it away into the manufacturing districts. That would apply to every town on the line; because, notwithstanding the vast quantity of goods manufactured in Lancashire and Yorkshire, there is a vast deal more flour eaten than there is piece-goods sent away, and the preponderating load is always inwards. There is all the food sent inwards, with all the raw material for manufacturing purposes inwards, a vast portion of which is entirely extinguished in the process of manufacture; and the export is merely a manufactured article, a fraction of the weight that is brought in. With a Broad Gauge line in those positions, the enormous additional cost of accommodation would have been something that I think has not been well considered by the advocates of the Broad Gauge, who are, luckily for themselves, situated in a district where is a very large passenger traffic, and not much merchandize.

The average proportion of weight inwards to Manchester.

Captain J. M. Laws.

1698. One great objection urged to the Broad Gauge is the great porportion of tare. Now in a district such as yours, where you can load to almost any extent, such an objection would not apply in the same degree, supposing your line were less tortuous; so that, as far as regards quantity of load, the Great Western Gauge would be a better Gauge for your line?

As far as regards the mere loading as to the quantity of tare, there would be no disadvantage on the part of the Great Western, because their empty waggons, I apprehend, would not be a heavier load to bring back in proportion to what they carry than ours. Our waggons are very light now. We carry all those heavy loads of twist and flour on nothing more than the bottom of the waggon. The bottom is very strong. The four wheels weigh about 22 cwt., and the frame of the waggon is made very strong.

1701. Do you happen to remember what your greatest width is?

About 8 feet. The horse-box is the greatest width we load. We have nothing in the shape of a load so wide as the ordinary sized horse-box.

Convenience of Passengers.

1702. Has the Narrow Gauge any superiority over the Broad Gauge for passenger traffic, in your opinion?

I do not think it has. We are now making carriages to give accommodation to private parties where you can select your party; but that could be equally done with the Broad Gauge. I do not think the Narrow Gauge has any advantage over the Broad Gauge for passengers, with the exception of their being less costly and better adapted for general purposes in going into a difficult country; but when you leave that country, and the point of connexion is of no great importance—for example, if I am going from here to Bristol, I think the Broad Gauge is as good as any other, if it were not for the inconvenience of not being so well adapted for general purposes.

Captain J. M. Laws.

Safety

1703. Is not the greater base of the Broad Gauge an element of greater safety for trains running at high velocities?

Base of Narrow Gauge sufficient for safety. Comparison with a ship launch.

I do not think it is. I think a narrower Gauge considerably less than 4 feet 8½ would be as safe as you could want it. We never heard of a train upsetting. I think you may take as an illustration the case of a ship on the stocks. Here is a first-rate of enormous height above the points of support; so that the ship in reality is supported by only one-third of her extreme breadth, and frequently she has a number of people, a great top weight, running about. The ship is launched, supported by one-third in the centre, and we never heard of a ship upsetting off her cradle in the Queen's yards, where the ways are perfect. The fact is, that if there is any inclination to upset, here are two-thirds acting against one-third to keep her in her place. The centre of gravity in a first-rate man of war is vastly higher, I should think, than an ordinary railway train, because the weight of a railway train is principally in the wheels, and they are under the body.

To say that they were as safe, would be reasoning against mathematical demonstration. It could not be safer, but I know that the existing points of bearing are far within the extreme of safety, and beyond necessity, as regards safety. I think I can demonstrate it in this way:—we very frequently have a single horse in a horse-box; that horse is frequently put on the extreme side of the horse-box: it is not a good plan, but it is so. The horse-box is the widest vehicle we have, and the horse is clearly the highest load in proportion to this centre of gravity, and if there is any yielding at all, he yields to it, and gives a much greater effect towards upsetting the train than anything else; but we never hear of one upsetting.

1712. Does not the greater width of the Great Western waggon admit of the centre of gravity of the

load being kept much lower than in the Narrow Gauge waggon?

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Certainly it would; *but I should think there is no advantage where you have a thing that is perfectly safe, in spending money to make it safer.* We have never had an instance of a waggon upsetting. Now the coal waggons are made sloping, from about 7 feet at the upper edge to about 3 feet 6 inches at the bottom. The centre of gravity would still be in the centre, but still a considerably preponderating part of the load would be projecting beyond the centre of the road. The safety would be increased from its coming between the wheels where the bottom of the ordinary load would be a foot higher than the coal waggons.

No advantage in expense for making safe safer.

1713. Then you think you have a surplus of safety with the Narrow Gauge as far as regards the upsetting of the waggon?

That is my impression; as regards safety from the position of the centre of gravity, we have a vast margin to go on with the highest load I have ever heard of yet, that is with the horse-box, as I before described. I have seen many first class London and Birmingham carriages with a ton weight upon the top of them, and very little weight comparatively under. You see an enormous quantity of luggage packed on the top of those carriages, so that they have the fairest possible chance of upsetting. But I apprehend that the safety of the road is not limited exactly to the Gauge, because the journals of the axles project considerably beyond the rails, and the points of support of the carriage is on the extreme point of the axle.

1664. Are not higher speeds attained upon the Great Western than upon any of the Narrow Gauge lines?

I cannot understand why they should be; it is a general prevailing opinion that that is the case, if it be so, it must arise from the fact only of their having

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Speed.

more powerful engines. I have no doubt they have very powerful engines, and they have a very easy gradient line; but, on the other hand, I do not understand why they should attain a higher speed with the same weight in proportion, to prove which we are now running our trains at 45 miles an hour. We are obliged to do it to keep our time, on gradients varying from 1 in 44 to a level, with hardly any portion of a straight line; but we are running 45 miles an hour, and for the last two months our express trains have been working at that speed, without being five minutes after time.

1665. Do you mean that that is the maximum speed between station and station, or the average speed?

Average speed on Leeds and Manchester of express trains 45 miles an hour.

That is the average speed, including the whole journey while the train is in motion; they cannot keep their time under 45 miles an hour, and I can demonstrate that at once. We use no stationary power; we start from the Victoria station for a mile and a quarter on a gradient varying from 1 in 44 to 1 in 60.

1666. What length of gradient have you of 1 in 44?

About half a mile, and about three-quarters of a mile of 1 in 60. We then take a gradient of 1 in 150 for eight miles. We then have a level for about six miles, and then through a tunnel of 1 in 330, and then a descending line nearly all the way to Leeds. There is no part of the other portion of the journey worse than 1 in 300, and a great part descending. We have a descending line of 1 in 182 for eight miles, passing round two curves of ten chains each.

Curves.

1667. What is the length of those curves respectively?

About a mile. Where a tunnel was abandoned, there is an S curve, they join each other, and are under half a mile each.

1668. Do you imagine that engines with the Broad Gauge would take those curves?

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Certainly not so safely. Besides, we could not get them into 1 in 10 with the Broad Gauge: they must be sharper with the Broad Gauge considerably. There was a tunnel that we intended to have made: the whole side of the mountain came down; it was just at the foot of the mountain where the tunnel was to have gone through: we found the material composed of the *débris* of this mountain: the moment we touched it, the mountain began to slip, and we cracked a farm-house and some buildings almost two-thirds of a mile from where we touched this hill, and we were obliged to abandon it. It crushed the tunnel in, and 18-inch balks, as you would this pen. The canal is just below the turnpike-road, just below that we were obliged to divert the turnpike-road, and we had great difficulty to get room enough to divert to do so, for the mountain began to squeeze up the bottom of the canal. We were obliged to adopt these S curves, which are about 10 chains on a gradient of 1 in 182: but we got the curve part on a level. If the Gauge had been wider, of course the curves must have been sharper.

Acute curve caused by falling of mountain.

Railway catastrophe.

1669. And that, you think, it would have been impracticable to work at high velocities?

It would have certainly diminished the safety, and consequently the speed. I very much question whether, in the position of the Manchester and Leeds line, where in the 50 miles between Normanton and Manchester there are not four miles of straight line, a Broad Gauge could run with safety at the speed we are now running; for that distance, we are obliged to be constantly on a curve.

1670. It is in the valley of the Calder?

It is in the valley of the Calder and the Roche.

Mr. T. C. Mills.

August 28, 1845.

MR. THOMAS CHESTON MILLS, Manager of the Goods Department at the Camden Town station.

Break of Gauge.

1965. It is left to a subordinate officer to decide on the locomotive power to be furnished?

It is left to the managing officer of the locomotive department, who is on the spot, to decide what engines he will send out.

1966. Has he the power of diminishing the extent of the train, or is he bound to supply exactly the amount of power that the train you have made up shall require?

There has never, that I am aware of, been an instance in which they have requested any waggon or waggons to be taken from the train for the train to be lessened at all.

1970. Who are the most extensive carriers on your line?

Pickford and Co.

1971. Is the amount of trade they bring to you much more considerable than any other carrier?

Chaplin and Horne approach the nearest to them.

1974. Do you send your goods waggons from the Camden Town station to Hull?

Yes.

1975. Looking at the ordinary making up of your trains and goods, do you apprehend that any great inconvenience would result to your Com-

pany or to the carriers, if, on any part of the whole distance from Camden Town to Hull on one side, and Camden Town to Liverpool on the other, a change of Gauge were to take place at any intermediate station?

It would have the effect of creating an extra expense upon all the goods so transferred, and also of occupying a greater length of time in the transmission.

1976. From your experience at the Birmingham station, should you be disposed to recommend the unloading of the goods generally and reloading into carriages of another Gauge, provided a break took place at Birmingham; or would you recommend an intermediate rail, to form a double Gauge, one for the broad and the other for the narrow, to be used, and the same waggons to run on the whole distance; or should you recommend the articles being lifted bodily from the carriage of your Gauge to corresponding carriages of another Gauge?

I should certainly recommend, that if a broad line intercepted the Birmingham line anywhere, and goods were to be conveyed upon it, an extra line should be laid down, and that the goods should not be removed from the waggon in which they were originally loaded.

1977. Do you think that would be in the long run the least expensive arrangement?

Decidedly.

1978. Have you at all entered into the calculation of what would be the increase on any line to have an additional Gauge upon it?

I have not. This is an engineering question which I have not at all considered.

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1979. Is not that one of the elements of the calculation, inasmuch as the interest of the money so laid out should be contrasted with the cost of transfer by hand?

I think it is not the usual custom of railways to make specific rates according to the outlay on their line. If a line of railway was laid down with three rails for each line instead of two, it would be at least one-third more expensive; but I should say rather more on account of taking more land. It would not follow that they would charge one-third per ton more for the conveyance of goods over that line.

1981. If there was no competition, would not the public be at the mercy of the Company; and if, on the other hand, there was competition, would they be obliged to bring down the price to meet that competition?

I think the price does not always depend on competition, but on the policy that is taken up by certain Boards of Directors. My own private opinion is, that a Railway Company gets more money by low charges and large quantities than it does by higher rates and smaller quantities.

1983. Have you ever had occasion to shift your goods waggons at Birmingham for any purpose connected with your business?

Example of delay of shifting load.

Occasionally; but such cases are very rare. For instance, we had a complaint from Kenworthy and Co. that a waggon they had despatched from Camden Town to Manchester had not duly arrived at 6 o'clock the next morning. On inquiry at Birmingham, I found that, upon its delivery to the Grand Junction Company, it had been discovered that a spring was broken, and it had to be unloaded and reloaded. The result was, that it did not proceed forward till the next day. Kenworthy and Co. had

no agents at Birmingham; therefore, of course, it would rest with the Grand Junction Company to make the reloading.

2004. Do Pickford and Co. bring up goods from Liverpool on the Grand Junction?

Yes.

2005. What becomes of the waggons containing those goods on their arrival at the Birmingham station?

Pickford and Co. send their own waggons to the Grand Junction station at Vauxhall, Birmingham, to receive their goods, and cart them to the London and Birmingham station.

2006. So that, in both cases, Pickford and Co. are exposed to the double transfer?

Yes, and there of course they have to reload them; the effect of which is, that the Grand Junction Company, whose goods leave Liverpool on Wednesday night, arrive in London at half-past 11 on Thursday morning, and are delivered at 1 o'clock. Pickford and Co.'s goods, which leave Liverpool by the same train, and arrive in Birmingham at the same time, are not sent forward from Birmingham until a quarter before 11, arrive in London at 7 in the evening, and are not delivered until the following day.

2019. Has it frequently happened at Birmingham that you have been obliged to change the waggon containing goods?

No; it is a very rare occurrence indeed.

2049. Are there any other observations you wish to offer?

I do not know whether the conveyance of cattle has at all attracted the attention of the Commission;

Mr. T. C. Mills.

it is an important particular. Last Saturday we carried 6473 animals into London.

6473 animals brought into London by one train.

2050. By what train?

They came by various trains: there were 229 waggons in the whole.

2051. Of what did they consist?

There were 550 oxen, 5571 sheep, 349 pigs, and 3 calves.

Fourth-part of that number would have taken a day to transfer.

2052. Supposing you had had to transfer a fourth part of that number from the Narrow Gauge to the Broad Gauge at Rugby, from your experience of driving cattle into pens, how long do you think it would have occupied?

It would have occupied a whole day to make the transfer.

2053. How long did it occupy to get rid from your premises of the largest number you received on that day?

Perhaps three quarters of an hour.

Mr. Joseph Sanders.

November 13th, 1845.

Mr. Joseph Sanders, Secretary to the Bristol and Birmingham Railway.

Break of Gauge.

The Gloucester station employs double the number of men of any other of equal importance, in consequence of the break of Guage.

5052. The Gloucester station is conducted in the same way as all others, by a chief clerk and under clerks, inspector and porters, but to an extent more than double any other station we have upon the line in consequence entirely of the trans-shipment; and that applies quite as much to the goods department as to the passenger department. I conceive that the additional cost to the Company alone is not less than 2,000*l.* a year in staff, exclusive of great increase in the expenses of the carriers upon the line. With reference to passengers' luggage there is more than twice the quantity mis-sent or lost at the Gloucester station, than at all the other stations (combined) between Birmingham and Bristol. The delays to the passenger trains, also, we find far greater at Gloucester than at any other station upon our line, which we attribute entirely to the trans-shipment. We conceive, also, that we are not carrying so many goods to a considerable extent as we ought to do, and should do, if the one Gauge were continuous from Birmingham to Bristol. We find that in the week ending the 25th of October, whilst we had to trans-ship goods to the extent of pretty nearly 700 tons at Gloucester, we only had to deliver over something like 50 tons to the Great Western at Bristol; and if the break of Gauge had been at Birmingham, we find that, including the goods we had to deliver at various stations upon the line, the trans-shipment at Birmingham must have reached 900 tons. There are various trows plying upon the river between Gloucester and Bristol, averaging, perhaps, from 40 to 50 tons each, the greater proportion of

Mr. Joseph Sanders.

which goods we have every reason to believe would have been put on the railway but for the break at Gloucester.

5053. What reason have you to think so?

From our traffic manager, who has had communication from parties who have stated to him (particularly with respect to articles of a perishable or breakable nature), that they would not subject themselves to unloading and reloading the carriages at the Gloucester station.

5054. Can you refer to any parties?

Complaints from Birmingham of trans-shipment.

Mr. Chance, of Smithwick glass-works. There have been frequent communications from him with reference to the trans-shipment there. There are several others whose communications I have seen from time to time to the traffic manager. I have not their names with me, but I can furnish them to the Commissioners.

Waggon containing five tons takes 50 minutes to trans-ship.

The time occupied in trans-shipping a waggon containing about five tons has been proved to be 50 minutes, which we consider very important; but the greatest difficulty that our traffic manager has experienced is in providing waggons of the Narrow Gauge to meet the requirements that may be brought up from the Broad Gauge; and if we were not working as one Company, I conceive that that would be a source of the greatest possible annoyance and confusion, because we should not have the means of knowing what extent of goods were coming from Bristol to Gloucester in Broad Gauge waggons, and we have the greatest difficulty in meeting them; as it is, it involves the necessity of keeping a larger plant at Gloucester than would be at all requisite if the rails were continuous upon one Gauge.

5068. How many men do you employ in a gang?

There are 19 additional porters, in consequence of the trans-shipment.

5077. It was originally intended that the Narrow Gauge should be laid down to Bristol, but, although I

Mr. Joseph Sanders.

was not connected at the time with railway companies, I believe I may say that the change was attributable to the influence of the Great Western Company. It is held also by gentlemen in the neighbourhood, who are abstractedly favourable to the Broad Gauge, that the break at Gloucester is exceedingly inconvenient at all times, and that the Narrow Gauge should be continuous to Bristol.

Gentlemen theoretically favourable to Broad Gauge consider break at Gloucester inconvenient.

5085. A detention of five minutes for passengers is hardly sufficient ground for much complaint?

Sometimes it is much more, and when we are running in to meet the Exeter trains, it has not unfrequently happened that we have been too late, owing to the change, and the same again in meeting our trains in Birmingham.

5102. Is it understood by the Company that in the event of changing the Gauge the stock of the Broad Gauge party must be sacrificed, or is it understood that it can be adapted to the Narrow Gauge?

I do not think the question has been very much discussed, but a sacrifice of the stock would much rather be made than continue the break of Gauge. The Directors consider it so important that it is not at all a question of cost with them.

5103. Do you at all contemplate putting a Narrow Gauge within the Broad Gauge line, or is it a total change?

A total change.

5104. Would it not be more convenient to you to have both the one and the other?

The Directors are advised to the contrary.

Mr. W. Bass.

Nov. 6, 1845.

MR. WILLIAM BASS, District Agent to Messrs. Pickford—connected with the Gloucester, Bristol, Bath, Bridgewater, Taunton and Exeter stations.

Break of Gauge.

5681. The goods upon the Narrow Gauge truck if they are light packages, furniture or bulky packages, are always put on the top of the truck, and are necessarily taken off to get at the heavy loading, in order to put it at the bottom of the Broad Gauge truck.

Average detention of goods trains at Gloucester break of Gauge four to six hours. Would prefer any system to breaking bulk.

5686. What is the average detention at the Gloucester station with the trains, in consequence of the transshipment?

I should say at least from four to six hours.

5687. In the event of the Gauge being continuous, there would be no detention at all?

None at all. I would prefer any system to breaking bulk.

5725. I think the lighter the weight you have to transfer the better; I consider Gloucester an exceeding bad place for break of Gauge.

5726. Do you not think that where the break of Gauge takes place there should be the least traffic?

To be sure I do.

5735. Before the opening of the Bristol and Gloucester line, I was consulted by the chairman of the Bristol and Gloucester, and by some of the Directors as regards the different establishments; it was at that time determined that the Broad Gauge should be put down, very much to the annoyance of the chairman of the Bristol and Gloucester, who is also a Director of

* Messrs. Pickford's gross receipts for carriage of goods and merchandise are said to be 900,000*l.* per annum.

Mr. W. Bass.

A Great Western director disapproves of Broad Gauge on Gloucester line.

the Great Western Railway, for he said it was the worst thing that could have happened for the port of Bristol, and for the Bristol and Gloucester line.

5736. Who was that?

Mr. Jones, the chairman of the Bristol and Gloucester Railway: he agreed with me in opinion that it was a pity that a continuous line had not been put down.

5747. As regards through traffic, a break of Gauge would be most convenient where there is least through traffic?

Decidedly.

5751. I should say that of our loading there is nothing like a tenth goes on to the Bristol and Exeter line compared with what stops at Bristol.

5843. You have stated that you have four men at Gloucester employed in transferring the goods from the one Gauge to the other; will you explain how it is done?

Extra establishment required by break.

One man is placed in the Narrow Gauge truck, after it is uncovered; two men are upon the platform to work the train; one man is in the Broad Gauge truck to load; the clerk stands by to mark the goods off, in order to prevent robberies; and this establishment is rendered necessary by the interruption of the Gauge; from no other cause; we are frequently obliged to have extra men when we have an extra quantity of loading.

5848. There is hardly a day passes but goods get wrong.

Goods would reach Bristol from Birmingham in six hours with uniformity.

5851. Supposing there was a continuous Gauge through Gloucester, how long would your goods be in travelling from Birmingham to Bristol?

I suppose between five and six hours.

Mr. W. Bass.

5852. And with the break of Gauge how long are they?

Take 48 hours with diversity.

Sometimes two days, or more. We have no dependence upon them, because if we have not time to make the transfer before the train leaves, the train from Gloucester to Bristol leaves at a certain time without waiting for our making the transfer, and frequently delays them till next day; there is no regularity at all.

Uniformity of Gauge.

5729. If the Narrow Gauge were placed upon the Broad Gauge line, between Gloucester and Bristol, would not that remedy, in a great degree, the evils you now complain of?

No matter to carriers what Gauge. They ask a uniform Gauge.

It would not matter to the carriers or the public connected with the goods, what number of Gauges they had, suppose they had a continuous Narrow Gauge.

5742. You think that any regulation that would admit of an increase of break of Gauge, in various parts of the country, would be a great public evil?

Most clearly, as regards the carrying, and it is not very convenient as regards passengers. I have seen inconvenience myself frequently in coming from Bristol and going to Birmingham; I do not like it at all. I would much rather put myself into a carriage at one point, and go in that carriage throughout where I am going.

Thinks Bristol cannot rise as a port without uniform Gauge.

5751 & 5752. I am quite satisfied that Bristol, as a port, cannot rise without a continuous Gauge. I am borne out in that remark by the disinterested portion of the trade at Bristol.

Convenience.

5737. The goods are mingled in the large trucks owing to the size of the trucks?

Broad Gauge truck takes much labour.

Yes; and the Broad Gauge trucks are exceedingly inconvenient; we find it so, because we do our own work at the stations, and the moving about a Broad Gauge truck takes so much labour. I had a practical

Mr. W. Bass.

knowledge of it the other day at Bristol. We were endeavouring to move a truck there; I was exceedingly anxious to get at some of the goods that were wanted in great haste for shipment; the truck was in the yard of the station at Bristol; I applied for assistance to the Railway Company, which was given to me; I got some of my own men, and I myself had to assist in order to move a great cumbersome Broad Gauge truck, requiring upon that occasion, eight of us to move it. A Narrow Gauge truck a couple of men would have moved with great ease. The Broad Gauge trucks are most inconvenient for the carriers' purposes generally. I speak completely disinterestedly; I have no share in either the Broad Gauge or the Narrow in any way. I have nothing to do with them; and, as carriers, it matters not to us whether we carry by the Broad Gauge or the Narrow Gauge, but it is for the public; if the carriers or the Railway Company are put to extra expences by working an inconvenient Gauge or truck, it must fall eventually upon the public. A carrier, in doing his business, must calculate his expenses, and the moving of these heavy trucks comprises a part of the expenses; so that eventually the public does and must pay for it.

One required eight men to move it.

Moving of heavy trucks forms part of a carrier's expenses.

5738. The trucks in question are 6 wheeled trucks?

There are a few 6 wheeled trucks; a far greater number of 4 wheels—nearly the whole.

5739. What do you suppose is the gross load in these trucks?

They vary from 4 tons up to 6 tons. I have seen them 5.18, the truck itself; then putting the maximum weight of goods at 6 tons, it would be 10 or 12 tons. In the other case it would be 5 to 6 tons. Then many parties have observed that the Broad Gauge trucks will take more loading; it is true they will, but it depends entirely upon the description of loading; as regards the article of cheese, for instance, a case came before me the other day; a quantity of cheese was loaded in a Broad Gauge truck; there was too much loaded together, and when we got to Gloucester

Cheese injured in Broad Gauge by excessive superincumbent weight.

Mr. W. Bass. it was very much injured. Now, in putting it into a Narrow Gauge truck, we could not have put the same quantity, so as to cause the pressure.

5741. It was caused by the superincumbent weight?

Yes. Then as regards pipes of wine and spirits, and all that description of loading, I never liked the system of what we call "saddling" that is, putting five or six pipes of wine at the bottom, and then putting one between each, I have seen injury arise from it. I have had thirty years experience in the carrying trade.—I have been connected with the house of Pickford now nearly thirty-one years.

5743. Is it the fact that for road station traffic it is generally more convenient that the trucks should be small rather than large?

Certainly.

Road stations require small trucks

5744. Is it desirable that you should pick up a single truck, or any number of trucks at each station, rather than load a truck partially?

Yes; our first station from Gloucester is at Cheltenham; we are allowed a minimum weight of 20 cwt; nothing could be better than that arrangement.

5745. It does not retard the luggage train?

No; with proper management it could be put at the end of the train, and it causes no detention.

5746. And, in like manner, the taking up such a truck causes no detention?

Precisely.

5753. You often travel by railway on both Gauges?

I do.

Passenger Comfort.

5754. Speaking as a traveller, what do you think of the convenience of the carriages, and the steadiness of the motion upon each Gauge?

The convenience of the carriages upon the Great

Mr. W. Bass.

Western is exceedingly good; but as respects the motion, there is much more motion upon the Broad Gauge than upon the Narrow. I experienced it on Tuesday evening.—I came up by the Broad Gauge to Gloucester, by the express train to Birmingham; the motion upon the Narrow Gauge was much less than upon the Broad Gauge; and the very best travelling I have ever had was upon the express train of the London and Birmingham. The new carriages are exceedingly comfortable and roomy.

Great Western carriages for passengers convenient, but more motion than on Narrow Gauge.

5757. With regard to the number of persons who are upon one seat, do you prefer four on a seat or three?

Three; but I prefer the two. I came up by the mail from Birmingham yesterday, and I prefer the small mail carriages decidedly; there was ample room; there were four in the carriage that I came up in, and I did not observe they were at all close; they were exceedingly comfortable. In the coupé they have only two, and I prefer that.

Prefers two on a seat to three or four.

5760. How do you like the Great Western second class carriages?

They are a very great improvement upon their original second class carriages, as they are upon the Narrow Gauge.

Mr. W. J. Chaplin.

Nov. 4, 1845.

Mr. W. J. Chaplin, Chairman of the South Western Railway Company.

Opinion on Gauge.

5439. Have you found any inconvenience in the working of the line from the narrowness of the Gauge?

No, certainly not.

5440. I am not a very scientific man, as you would naturally suppose, and I must confess that in the early periods of our performance I felt some regret that it was not a wider Gauge, but evidently I have lost those feelings lately. I have recently been much more satisfied with our Gauge. I thought the other looked more comprehensive, and was a better model for a railway in the early periods of it, but I have changed my opinion.

5441. Though you do not profess to be a scientific man, you have great commercial as well as railway knowledge; are you inclined to believe that you would have acted more economically in laying down a Broad Gauge?

No; and I think the principle of managing railways is altering. We used to think it was a bad thing to increase the number of our trains. I think now every one must feel that to make more frequent departures, and go quickly, and avoid double and treble engines, is a much better way, and therefore I think the Narrow Gauge comes better into play, because you can do that with less expense.

Frequent departures more approved than formerly.

5442. The Broad Gauge advocates state, that they are enabled to carry less expensively by working

Mr. W. J. Chaplin.

larger engines, and that they thereby supersede the necessity for the greater numbers of trains, which must be drawn upon other lines?

Comparison of the two systems.

Yes; but I think that will not be the proper course; every one must feel that the more frequent the communication, the more trade it creates. If you wish to avoid those very lengthy trains, the Narrow Gauge works more economically, at least that would be my view of it. I believe it gives more general accommodation.

5443. I suppose you anticipate, like the rest of the world, a great extension of the railway system over the country?

Whether I contemplate it or not, it is forced upon us.

5444. Do not you imagine that when that system is developed and extended, there will be greater reason for having a Narrow rather than a Broad Gauge, from the probability of there being lighter trains?

If I take a right view of it, it must apply to the whole.

5445. You therefore think it is more economical to work trains with small carriages than trains with large carriages?

Yes; I think frequent departures are a desirable measure for the public accommodation, and if you do not require immense trains, by having frequent departures, the Narrow Gauge is more advantageous to work.

Break of Gauge.

5449. There are two or three modes suggested of transferring the load from one Gauge to the

Mr. W. J. Chaplin.

Remedies.

other: one is by manual operation, another by a mechanical lift, and a third is by running the Narrow Gauge truck upon the Broad Gauge truck, and taking the whole load in that way to its destination; I presume you think that all those modes are, to a certain degree, objectionable?

Considers manual operation, mechanical, lift, and Narrow Gauge on Broad, all objectionable expedients.

Most unquestionably; because, if you shift it by machinery, I do not know that I am quite right in my view as I am not very scientific, but I have fancied, that, placing a wide-bottomed carriage heavily laden on a narrow base, on the Narrow Gauge wheels and axles, must tend a good deal to create motion, and that going quickly round the curves it must be very prejudicial. I should fancy so. Then again, if the Gauge were widened on our lines, the side of the rail must be brought much nearer to the edge of the bank than it is now, and in case of any accident, there would be no opportunity for it getting into the earth or bank, but it must go right over at once. Then, with respect to unloading, I am quite sure that that must be a dreadful inconvenience, and cause great expense, because responsibility for the articles is concerned in that measure; it would not only involve hand labour, but it would want a superior person for inspection. In all cases of loss, there would be a doubt unless there was a person to inspect the loading and unloading at each end of the Gauge, you would never satisfy yourselves or the public where the loss was caused, and it would expose the railway company and carrier to great liability, because the subordinate people, knowing that you had no check upon them, would be practising upon you.

5470. Suppose (to put a case) in coming from Liverpool there are some goods to come, but not a complete load from Warrington, that there are

Mr. W. J. Chaplin.

some goods but not enough to load a truck from Stafford, and so on at the different stations on the road, in what manner would you take those? would you take a partial load in a single truck from each place, or would you attempt to unite the loads from the different places in the same truck?

It must depend upon the quantity. If there was anything like a ton and a half or two tons at one of those stations, we should appropriate a waggon to its especial use, but if there were only half a ton, it would not be judicious to send it in a waggon by itself, and it must be mixed with others.

5471. For the purpose of taking it up, should you stop the whole train while it was put into the truck?

You must do so, certainly, if you have not enough to fill a waggon at that especial place; the train must be stopped while you put the part of the load into a larger waggon. There is where a lesser waggon would be more generally useful decidedly.

5472. Because in the greater number of cases one truck would be reasonably well filled?

Exactly.

5473. What number of carriages do you consider to constitute an average passenger train? How many carriages do you put on upon an average in a train?

We think a train a respectable train, and we can perform our business very well with 12 carriages; but it would depend, in some measure, upon the gradients; we run upon our line very satisfactorily with 12 carriages.

5480. Our merchandize train is a very uncertain one, it depends much upon the arrivals of the packets and the departures of them.

[illegible]

Nov. 6, 1845.

Mr. Joseph Hayward, connected with the Firm of Pickford's.

Convenience.

5819. Will you explain the way in which trucks are loaded, and in which they are taken up and distributed for the road-side traffic as well as for the through traffic?

Our great object is to send a truck to each point we carry to; we send one to Wolverton; another for Northampton, to the station called Roade; the next station we come to is Rugby, where we divide; we have one for Rugby, one or two for Leicester, one for Derby, one for Nottingham, one for Chesterfield, one also for Sheffield and Leeds: then we go on to the Hull and York line; we have trucks to Hull, to York, to Darlington, and to Newcastle; at every point we endeavour, as much as possible, to make a distinct load, so that it may not be interfered with, because every interference with a load causes more or less damage to the load, and great cost attaches to goods when they are shifted in any way; if we cannot make a load to these points, we centre at Derby, because goods from the west come up to Derby, and we can there mix them with the goods from the south, and make a distinct load to those points north of Derby.

Carriers endeavour at every point to make a distinct laod.

5823. From this statement of your practice it appears that you would experience great difficulty if the trucks were much larger than they are at present?

A large truck would take more than could be conveniently sent.

Certainly, because they would take so much that we could not send direct; every place must either have a trans-shipment, or be left a day to make up that weight; but by this system we are enabled to accommodate the

public with a daily conveyance to those places, and many more which I have not named.

5836. The less anything is moved when it is once started the better it is for it.

Trucks unloaded as little as possible.

5841 & 5842. Our trucks are unloaded as little as possible on all the lines on which we have traffic, except at Gloucester. Mr. Bass can speak much more to Gloucester than I can. I can speak to its inconvenience, for I have stood there nights together to see it going on. We are obliged to have horses and immense power to move those immense trucks out of our way.

5845. Do you receive complaints from different parts of goods lost or goods injured?

Yes.

Coals may be transferred direct, but light goods must be taken off the top and replaced on the top of second truck.

5854. A man in trans-shipping a load of coals begins at the top, and puts the coals that were at the top into the bottom; but with us we must put all the light goods upon the platform and put the heavy goods in again at the bottom and the light at the top; so that it is double the labour in trans-shipping general goods that it is in trans-shipping such articles as iron, corn, or coals.

Comparative Utility.

5824. In your opinion would the public prefer a frequent conveyance to every place not remarkably quick, or a very quick conveyance to every place, but not so regular?

Regular convergence more important than rapid.

Very quick conveyance is not wanted; what is wanted is a regular conveyance once a day; and it is much more important, both to the public and to the carrier, to have it regular than to have it very quick.

5825. Suppose you had a large trade from London to a distant point, such as Newcastle, and very little road side traffic, would you prefer large waggons for that purpose, or small ones?

Small ones; for this simple reason,—our goods come

Mr. Joseph Hayward.

up from the city for different parts at different times; we get a small waggon, we load it with the weight, and it is consequently off our hands, and there is room for another, and room for other goods; if we were to have large waggons we could not move them; we should want a much larger space, such a large space as cannot be had in the neighbourhood of London, and there our goods must lie in all directions to our inconvenience; all put down, and requiring more labour to put them up again.

Small waggons soon disposed of and loaded; large waggons require great space and hard to move.

5826. There are some goods packed in very large parcels, such as hops and wool?

Yes; as regards hops we can carry upon those small waggons from 35 to 40 pockets, and they cannot carry many more upon the large waggons, because their size will not admit of two pockets: a pocket of hops is 6 to 7 feet long: the Narrow Gauge waggons are 7 feet to 7 feet 6 wide, so that a pocket of hops just fits it in laying it across. A Broad Gauge waggon is 9 feet wide, consequently there is 2 feet of waste room in loading hops which cannot be made use of; it is all lost.

Pocket of hops fits across a narrow waggon; two feet breadth wasted in broad waggon.

5827. Could you not lay them lengthwise?

In loading them lengthwise you lose ground again; a Broad Gauge truck is 18 feet long; a pocket of hops being about 7 feet, you lose 4 feet of length; the Narrow Gauge waggons on the South Eastern, which are made purposely for hops, and on the London and Birmingham their new waggons run from 13 to 14 feet long, so that we can just squeeze in two pockets lengthwise; so that there is room lost in an article like hops, and there is also room lost in an article like wool.

Pocket of hops 7 feet long. Broad waggon 9 feet wide.

5828. How do you carry timber?

It is by two or three trucks being coupled together, and having upon the top of that a moveable cross-piece of wood, with an iron through it, which allows the timber to work as they go round the curves.

5834. Occasionally, have there not been instances in which it would have been desirable to carry larger

Mr. Joseph Hayward.

pieces of mechanism than you could very well carry?

We have never had anything yet but what could be carried; we have carried 11 or 12 feet turn tables whole: our own turn tables in our own warehouse are 11 feet, and they were all brought up whole on the London and Birmingham.

Prospects of the Railway system.

5838. There has been a very great division of traffic since the railways opened from the North of England to the West of England which used to pass through London previous to the railways being opened.

Railway system promotes direct traffic, withdraws much from London.

The traffic will be divided very much now, according as the lines of traffic open through the country; there will be a great deal withdrawn that used to pass through London. We always followed the same plan in our boat system when it was at its height, before the railways came into operation, of always loading direct to towns where it was possible, the cost of trans-shipping and the loss by damage was so very great.

Uniformity of Gauge.

5860. Suppose that by the extension of the Broad Gauge into different parts of the country there were intermingled the two systems, the one of Broad Guage railways and the other of Narrow Gauge railways, intersecting each other at various points, do you conceive that your traffic, when it is started upon the Narrow Gauge railway, would be confined to the Narrow Gauge, and that which started upon the Broad Gauge would be confined to the Broad Gauge?

Difficulty of working now with railways converging to a point. Break of gauge would increase inconvenience.

Certainly; I do not see how it would be possible to work it otherwise. Now, with the intermixing of railways at various points, it is very difficult to keep it straight, and I do not know what it would be with the two Gauges together.

Mr. B. W. Horne.

Oct. 30, 1845.

MR. BENJAMIN WORTHY HORNE, (of the firm of Chaplin and Horne, Carriers upon almost all the principal lines of railway in the country).

Break of Gauge.

4746. There seems to be a great probability of the Great Western system interlacing considerably with the Narrow Gauge system; and the Commissioners are desirous of knowing whether you, as one of the greatest carriers in Europe, would find inconvenience from a frequent change of Gauge?

To avoid re-loading, carriers pay for the full load of a half empty truck.

Yes. With a view to avoid re-loading, even at present, I will give an instance of what we do. According to the present arrangements with the railway companies, the Manchester and Birmingham Company, the York and North Midland, the Midland Counties, and all those lines, limit us to so much weight in a truck: supposing that truck has not the full weight in it, we would rather pay the difference than have the goods in that truck subjected to being turned over. There are so many things we suffer from: there are three places where we are liable to robberies, and where we lose more money than we get for the carriage; that is, at Birmingham, at Derby, and at Leicester: those are three places where we encounter losses and delays.

4748. What do they charge you per truck?

Two tons; that is to say, supposing we have a lot of Manchester packs and put them into a truck, and only get one ton 15 cwt., then we have to pay for two tons; if we have more than two tons, we pay for more; if we have only one ton, we pay for two;

Mr. B. W. Horne.

but I say if we have not two tons in the truck, for the sake of a few shillings it is not worth while to save the difference: but supposing we are two or three hundredweight short, we send the truck through, and pay the additional 3*s.* or 4*s.* to save re-loading.

4750. Supposing at Normanton there should be a change of Gauge, and that all the carriages arriving there from the North were to be run upon the Broad Gauge, what would be the effect of that?

A change of Gauge at Normanton would ruin carriers' trade in bad packing and injury to goods.

It would ruin our trade: we should have cloth from Huddersfield, Bradford, and Halifax there. Now the friction alone sometimes will amount to three or four pounds in a truck-load from bad loading, although we may have a reasonable time before starting, which could not be ensured at reloading.

4752. But suppose the companies undertake the shifting of the goods bodily, by putting the entire load upon another set of trucks?

There will still be the chances of any delays arising from the late arrival of the train, and many uncertainties. But as far as relates to the unloading and reloading, we pay 1*s.* 6*d.* a ton at Derby, at Leicester, and at Birmingham. There is another point that is material: supposing you shift the goods from one Gauge to another, and the trucks are of different dimensions, you will not have enough to fill a truck, or too much for one truck, except both are nearly alike. A certain quantity of goods are required to fill a truck with safety to save friction, which is a very common thing in a Manchester pack, and if this same quantity of goods are put into a truck which has more room than the lesser one has, the result will be, we should have to encounter damage, because from the oscillation of the train everything rubs. We have that as it is, more or less, but we have it more when we do not have a full load. The fuller the load the safer the goods travel.

Inconvenience of trucks of different dimensions. Danger of friction.

The fuller the load, the safer the goods travel.

Mr. B. W. Horne.

4757. So that you think that the system of breaking bulk is one that would tend very much to injure your trade in every way?

There cannot be a question about it.

4772. With respect to the general course of the traffic, you bring a good deal through Birmingham?

We bring an immense quantity from Liverpool, from Manchester, and from the Potteries, and of Cheese from Chester. Now that is the most tender article that can be made for shifting. Sometimes we pay as much money as the carriage amounts to between Chester and London. That is to say, suppose our cheese account with a man is 60*l*., the cost of a truck will be 50*s*. or 45*s*. a ton from Chester to London: when we unload that truck-load we should find that the amount of carriage of one truck-load of cheese is gone by the damages, and that those damages arise when we have not a sufficient quantity to make a truck by reloading them at Birmingham. Supposing it is a small load of cheese, say one ton, for London, and 2 tons 10 cwt. for Birmingham: when we get to Birmingham we take out that which is for Birmingham, and send on that which is for London; and the cheese we send on is likely to meet with some misfortune. For instance: three cheeses might travel upon one another pretty well, but if you have four layers of cheese you will find that the friction and shifting will cause them to be very much injured. Now, at the last sale, we had 80 tons from Chester alone, 40 for Manchester, and 40 for Birmingham; and we shall have that every sale up to next May, and we should not like to have those cheeses shifted.

Cheese likely to be injured by unloading and re-packing.

At the last Chester sale, 80 tons of cheese, 40 for Manchester, 40 for Birmingham.

About 30 trucks come daily to Birmingham from the north. From 24 to 25 of these trucks go through Birmingham without shifting. There are 12 or 14 from Manchester direct, that are never touched. The number of instances in which we have our trucks left behind at the present moment from trans-shipment are enough to sicken one of the change, because the

Trucks left behind from want of time to trans-ship.

Mr. B. W. Horne.

inconvenience is very great when there is a late arrival of the train. The Grand Junction Company agree to arrive at Birmingham at 3 A. M.; the next train from Birmingham goes on at half-past 4 A. M.; if they are in at half-past 4, the London and Birmingham must start at that time, and the trucks that do not require to be trans-shipped come on, but they stop those trucks that have to be trans-shipped; and if that happens by the last train of the day, we do not get our goods that night, and we cannot deliver our meat or anything till next day. This is a daily occurrence. There are three trains a-day with trucks, and you are sure to have by each of those some trans-shipments.

4776. Then, taking the whole question, is it your decided opinion that any trans-shipment resulting from a break of Gauge would be a most serious evil?

With break could not satisfactorily conduct a large business.

We should not be able to conduct a large business with it with any satisfaction to the public or ourselves. We never know when a goods train is going to bring the heaviest quantity. If we bring our goods in time for the first train, of course they go by the first train; if not they go by the second train.

4786. It is only where the trade is very small that you have to break bulk?

Carriers prefer small truck except for hops and wool.

Yes. The traffic of York is nothing.* As carriers we prefer the small truck, except for hops and for wool, and there the larger the truck, the more we get into it. There are trucks on the Midland line which take four tons. We send yeast to Liverpool. We can put nothing whatever with the yeast: we send it in barrels, and send a large truck with this yeast. Supposing it burst, every article that was with it would be ruined.

* The general sense of the evidence shows that as yet our agricultural districts have not derived anything like the full benefit of the railway system. Under a complete and uniform network of railways, parish roads will converge to road stations and sidings, and farmers will combine to fill a truck with the products of their farms or purchases. Coals, lime, draining tiles, &c., will arrive, and corn, cattle, and green stuff depart from the foci of highways, traversing distances easily covered by a one-horse cart in a morning.

4786. Supposing a number of railways to unite at Rugby, in any case it would be desirable that they should have the power of carrying their trucks through without breaking bulk?

Certainly. If the traffic of Liverpool and Chester were brought to a focus at Birmingham, they must unpack there some trucks, and they would repack them to London.

We could not have all our Leeds goods and all our other goods shifted at Rugby.

4793. So as to avoid the break at Rugby?

Yes, certainly; they would not have a second one. They must of necessity have one at Birmingham, and, therefore, they would load all for Oxford in a truck of a mixed character; and when they got to Rugby, there would be no occasion to break bulk again, for they would be sure to find enough to make up the truck without being broken at Rugby.

4794. Therefore, with reference to such trade, it would be desirable that there should be no break of Gauge at Rugby?

There would be no benefit from it, but great injury.

Carriers' Convenience.

4787. The larger the waggon the greater number of times it would have to break bulk?

Yes, decidedly; further than that, we should have one or two inconveniences with a very large waggon. Supposing it held five tons, then five tons would all go into one truck; that would not be very convenient to us, because now we get two waggons, and unload those very quickly; but we could put no more hands upon a large one. Yesterday morning the train was not in till half-past 6; we ran two trucks into two different places, and put two sets of men upon them, and partly made up for the loss of time; but if we

Two waggons admit two sets of men to unload.

had one large truck we could not put more men to unload. Mr. B. W. Horne.

4797. We have the privilege now of sending one ton from London by any truck; that is to say, we pay only for one ton. Now it is impossible that a large truck could be allowed by the Company to go with a single ton in it, because a single ton will amount only to 14*s*. One ton in a truck will almost suffice daily for the smaller towns. The trade from London to those non-manufacturing districts is such, that we can get a ton to them, although we cannot get a ton from them: for instance, Stafford will take a ton, and Crewe will take a ton, and many other places.

4803. As a frequent traveller by railway, do you find any marked difference in the steadiness of the express trains upon the Broad and upon the Narrow Gauge? **Comparison of the two systems.**

I have ridden by them all, more or less. There is a difference upon the Eastern Counties. I recommended Mr. Barlow, of the Dover Railway, to go upon the Northern and Eastern express train, which was a favourite train with almost every body, and our coaches to Norfolk were forced to go by that train when our trade was conveyed to Hockerill by it, and it went on very well till the accident happened. There was no inconvenience arising from it; as between Birmingham and London, which I frequently come up by, I have felt a sensation, but it has only been for a few moments. We came at the rate of 60 miles an hour from Birmingham and Coventry up to Rugby. We left a quarter of an hour beyond our time, and we were up to our time at Rugby.

4804. Did you find much unpleasant oscillation?

Very little,—and I was in the last carriage. The way I tried was by taking a pencil and writing in both.

Mr. B. W. Horne.

4805. Do you find much difference?

I do.

The more compact the conveyance, the less oscillation.

4806. Do you find the Great Western the steadier?

Certainly not. I think I have found also a difference in the motion of the carriage from leaning against it. I think the closer and compacter the conveyance itself is, the less motion you find in the carriage. I said so before any question of the Gauge occurred, that the larger the vehicle, the more motion there is in the body of the coach itself from the velocity. You will find it precisely the same in an omnibus. If there is the least rickettiness in the carriage itself, you will find motion in the whole framework of the carriage; and I attribute it much to the height and size. There is more motion than in a compacter carriage; therefore, with a great speed, you will find more motion from the carriage itself, in proportion to its size: you will hear more cracking, just as you will hear in an omnibus compared with a stage-coach.

Miscellaneous.

4762. To what do you attribute the increase of the trade of Southampton; and what description of trade is it?

Export; and I have no doubt it will be increased by degrees. When we first began in connection with the Grand Junction Company as carriers to Manchester, when there was an outcry against the carriers, we were charging the public 3*l*. 10*s*. a ton to 4*l*. a ton, and that is now brought down to 45*s*. The consequence is, that we bring the trade to London direct, and thence direct to Southampton, whereas, before, it went by way of Hull; but now that we are so cheap by railway, there is an increased quantity on the line.

Cheapness makes trade.

MR. EVAN JONES, Agent of Messrs. Chaplin and Horne, at the Camden Station.

Carriers' convenience.

4812. Taking the trucks in the state in which they arrive at Camden Town, can you state the average load which is carried in each truck?

The up-loading averages rather more than the down. I think the up-loading averages 2 tons 15 cwt. to 3 tons, from the description of goods that come up being heavier than those that go from London; the down 2 tons each way.

4813. Are the trucks, for the most part, pretty uniformly loaded as to their weight?

Yes; except when we have sent trucks direct to small towns for the purpose of preventing transfer. We send even a single ton through to Huddersfield, Halifax, Rochdale, York, &c., to prevent disturbing the truck at Leicester or Derby.

[*Referring to the proportion of the quantity of goods which go through Birmingham without being unsheeted and unpacked (as would be the case if there were a break of Gauge there), relatively to the quantity which is re-assorted there, Witness handed in a statement, being the result of the operations of Messrs. Chaplin and Horne for one month. It appears that in this time* 1194 *trucks, containing* 2948 *tons of goods went through Birmingham without being disturbed, for Chaplin and Horne; and that only* 76 *trucks, containing* 190 *tons of goods, were transferred and re-assorted.*]

4817. Has a reduction of the charges of the London and Birmingham Company per ton, been made in addition to the privilege of sending a single ton in a truck at the price per ton?

Yes; to any of the road stations in respect of up goods, but two tons is charged per truck from Birmingham to London.

Mr. E. Jones.

4819. When a train starts from Camden Town, is it probable that half of it is to go to Liverpool?

No, I should say about a fourth of it; but the London and Birmingham Company are the parties to speak to this as to the whole train; I can speak to our own lading only with certainty, and our trucks through Birmingham are as 504 to 125 disturbed at that place.

4820. And what proportion to Manchester?

Probably about a sixth.

4830. Have you any additional remarks to make in relation to the injury which is done to any of your loads by loading and unloading, as mentioned by Mr. Horne?

I find that our damage and loss generally arises at those places where there is a transfer. Besides the time lost in moving goods, there is damage done in consequence of the time not allowing to repack them well; they put, perhaps, the heavy goods at the top, and the lighter goods at the bottom, for the sake of saving time, and the packages are damaged altogether. Transferring is a very great evil, and we frequently send light loads to prevent it.

4831. Can you give the Commissioners any statement of the injury which you have sustained from that cause at different times?

Loss on transfer 1*s.* a ton; cost of transfer 2*s.* 6*d.*

I could send a statement of the losses incurred, compared with the weight conveyed, and a return showing how often that occurred. We estimate the loss at 1*s.* per ton on such goods, besides paying 1*s.* 6*d.* per ton for some description of goods, and 2*s.* 6*d.* per ton on others for transferring, added to which, delays frequently take place. The weight transferred by us at Derby is about one-sixth of the whole passing that place, inclusive of the local traffic, and that to and from London. The weight transferred would be greater on the Broad Gauge, or the Company would be subject to a considerable additional expense for drawing dead weight.

Mr. J. Brown.

November 3, 1845.

Mr. James Brown, connected with the Mineral Trade of South Wales.

Comparison of Gauges.

5213. Have you at all turned your attention to the conveniences or inconveniences that would result to your district from having the Broad or Narrow Gauge introduced?

The Broad Gauge inconvenient in South Wales, where tramways 2 feet 8½ inches, and other lines to Newport 4 feet 4 inches, are in extensive use.

Iron works situated in series of valleys and sharp gullies unavoidable.

Yes, I have a strong feeling upon that matter. I think the Narrow Gauge far preferable. I think the Broad Gauge will be found very inconvenient. I look upon it in this way:—In the iron and coal works we have used 2 ft. 8½ in. narrow tram roads for the collieries, and those purposes. We have lines communicating with the port of Newport, with which I have had to do all my lifetime; they are 4 ft. 4 in. tram roads. All the works in Wales are situated in a continuous series of valleys, one after the other; they may be called gullies, for they are very narrow many of them, and sharp curves are unavoidable; and I conceive that the narrower the Gauge the better you can get round those curves,—because, in going round a curve, the inner wheel is bound to slide backwards, whilst the other is carried forward; and the wider the Gauge the greater the strain that way.

On sharp curves in Monmouthshire, locomotives come to a stand.

5223. In the Monmouthshire Canal Company's tram road they have very sharp curves; in fact, they could not well be avoided, except at a very enormous expense. There locomotive engines are used, and the strain is very severe; and sometimes they come to a stand still, in attempting to get round those curves.

5224. I think the waggons I have seen on the

Mr. J. Brown. Convenience.

Great Western—those large six-wheeled waggons—would be very inconvenient for coal traffic.

5245. You were understood to say that some of the carriages have stopped occasionally on the curves in some parts; are those locomotive engines?

Locomotive engines. Under those circumstances they go back again, and then they come with a sort of run to get over the curve.

Break of Gauge. Remedies.

5233. The Commissioners have been told by Mr. Cubitt, the celebrated engineer, that the whole cost of moving a quantity of coals (by mechanical arrangement) would be 1*d.* a ton?

Economy in mercantile traffic important.

It is important to get the traffic in merchandise carried on with as small an amount of capital as you can, because it enables a Railway Company to charge lower rates than otherwise; for I consider that the freighter, or those that send the coal or iron to market, pay those expenses at last.

5234. But, according to Mr. Cubitt's account, it would be merely an increase of 1*d.* per ton either to the producer or to the consumer?

I should very much question that sum in my own mind. I do not think that would be the whole of it. I think there would be found a great deal of detention and loss of time. A large staff of men would be necessary to work those several machines, if they are to be done all at once; if you are to do the work cheaply, you must do it with great regularity.

Mr. J. P. Budd.

November 7, 1845.

MR. J. P. BUDD, Manager of Copper Works and Coal Mines, Deputy-Chairman of the Welsh Midland.

Uniformity of Gauge.

6042. Are you at all acquainted with the quantity of metals that are now sent to the north from the South Wales district?

One ironmaster makes 50,000 tons a year, four-fifths sent to the north by sea.

I heard Mr. Bailey say that he made about 50,000 tons of iron a year, and that four-fifths of that went to the north—it goes by sea. Most of the iron made at Wales is located on the northern ridge of our coal basins, and are therefore 15 or 20 miles inland northward, so that the cost of getting on ship-board from those iron works is 3*s*. 4*s*. 5*s*. and even 6*s*. a ton, which at 1*d*. a mile would take us far northward. Hitherto South Wales has hardly participated in the retail supply of the country. It has gone by sea to London, Liverpool, and elsewhere, chiefly for foreign shipment; it has ascended but a little way into the interior, but if an overland communication is made, a great change must take place, for if a lot of 10 or 20 tons of different sorts of iron can be made up, and delivered at Derby, Leicester, or other places open by railway, the South Wales iron trade would pay more attention to quality. There is not a boiler-plate maker in South Wales. I believe that South Wales has been kept back, to its own injury, from having no canal communication enabling it to distribute its produce through the interior, as the great Staffordshire district does, which is the very centre and heart of the country. I am not looking at the mechanical part of the question, but merely looking at it commercially. There is a railway from Birkenhead to Chester, and from Chester to Wrexham, and there is also a railway now constructing from Wrexham to Shrewsbury. If you look at the map, you will see that when you get to Leominster, which is the centre of the country, every mile you go eastward, if

Wales has had a small share of home trade.

South Wales retarded in prosperity by want of inland communication.

Mr. J. P. Budd.

you want to go the Mersey, is so much lost ground. One great point for us will be an immediate delivery of goods to those parts; and unless there are to be parallel lines, we want a uniformity of Gauge. Then, looking at all the railway system east and north, I find the same; I take no mechanical views, but merely a commercial one, of the question.

Unless parallel lines of Broad and Narrow, South Wales requires uniformity.

6043. If you found a railway running to the east, and that were a Broad Gauge line, you would probably change your opinion as to which you would advocate?

Notwithstanding all the disadvantages of having the Wide Gauge introduced into the doors of our workshops, and at the mouths of our pits; notwithstanding all that enormous disadvantage, I should then choose the Gauge which would carry us the farthest. But there is another view which I wish to state; it will, perhaps, be a matter of some surprise, when I mention that there are now in our district, not less than 90 miles of Narrow Gauge roads.

Prefers the Gauge that will carry furthest.

Ninety miles of Narrow Gauge in his district.

6044. Are those public roads?

Two of them; the Taff Vale Railway is 34 miles of road, and there are 6 miles at present in construction for what is called the Aberdare branch, a Bill obtained last Session, that will be completed, I suppose, in the spring; and there is, besides, the Llanelly road, which is a public road; its main trunk and the branches are 45 miles long. There are also private roads—the Paleg road and its connection, six miles long. The Welsh Midland is intended to connect itself with these roads, carrying the traffic to the north.

6048. So that you consider the Great Western line as being entirely out of the question, in relation to the conveyance of your produce by that railroad?

Quite so. I should say that if the South Wales road were made of an uniform Gauge with the northern roads, it would be of great public advantage.

Mr. J. P. Budd.

6069. With reference to the break of Gauge, will you state the places at which any junction of different Gauges would cause inconveniences to you; and will you state how the question of the difference of Gauge enters into the consideration of the convenience of your proposed railway?

Break of Gauge.

I think that, supposing there was a break of Gauge between us and Birmingham, or between us and Birkenhead or Liverpool, or a break of Gauge disconnecting us with the north or east of England, that, looking at the nature of the traffic we anticipate in metal and heavy goods, the benefits of the railway would be greatly diminished indeed. I cannot fancy how 500 or 600, or 700 tons of iron (which, there being no break of Gauge, certainly would reach its destination by the next morning) could be transferred and shifted in the course of the night. My great wish is that we should have no break of Gauge at all. As to what Gauge we shall have, we, of course, are in the hands of Parliament.

Cannot fancy how 600 or 700 tons of iron could at break of Gauge be transferred in one night.

6071. Where are the places in which you fear a break of Gauge as possible?

I fear a break of Gauge as disconnecting us from Gloucester, Worcester, Wolverhampton, Birmingham, Birkenhead, Holyhead, Manchester, and Liverpool; in fact, the whole system.

6076. I would merely say, in addition, that having now the sending of goods to Gloucester, where they have to be transferred into other modes of conveyance, I have found the greatest difficulty and loss; frequently a parcel of goods is sent to the wrong party. Perhaps, after I have been months in endeavouring to get iron works to try this particular quality of iron, I send up a lot for them, and that lot gets sent to another party. Resulting from the break of Gauge?

Has found great loss from break at Gloucester.

Merely from the transference; the transference being into the basin at Gloucester.

Mr. E. Woods.

November 7, 1845.

Economy of Working.

MR. EDWARD WOODS, Civil Engineer, formerly Chief Engineer of the Liverpool and Manchester Railway.

5867. A paper has been handed in to us by you, upon which I will make some remarks, and request your explanation. On the Manchester and Liverpool Railway it is stated that the expenditure of coke per mile for the mileage of the engine is 24·4 lbs. for one half-year, and 21·9 lbs. for the other half-year. We have before us a return from several railways, the Great Western, the Grand Junction, the Birmingham and Gloucester, the South-Western, the London and Birmingham, in which the expenditure of coke per mile for the mileage of the engines is very considerably greater, the largest being 38 lbs. and the smallest 26·1 lbs. Can you offer any explanation of the consumption upon the Liverpool and Manchester being so small as compared with the other lines?

The consumption of coke upon the Liverpool and Manchester was very much higher four years ago, and beyond that time, than it has been in the last four years. The difference has arisen principally from the improvements of the valves of the engine, and the construction of the working parts generally.

Speed.

5886. The average speed of the passenger trains on the Liverpool and Manchester line, including stoppages, is given at 20 miles an hour?

I have taken the second, third, and first class trains altogether; the speed of our express trains is about 40 miles an hour, and of our first-class trains 30 or 32 miles an hour.

5887. Is there any strong wish on the part of the public of Manchester and Liverpool that the speed should be augmented?

I think not.

5888. Do the men of business require a greater speed?

I think not; it would make the difference of only a few minutes.

5891. Suppose it was found to be the desire of the public of Manchester and Liverpool that the speed should be much increased, is it your opinion that you possess the power of increasing the speed?

Clearly.

5893. Do you conceive that a fire-box sufficiently large could be obtained upon a Narrow Gauge line to give the requisite evaporation?

Yes, I should conceive that our boilers are the smallest of any in the country; we have only 48 feet of fire box surface, and 458 feet of tube surface; but those engines are capable of taking a train of 30 or 40 tons weight at 45 miles an hour.

5894. What is the evaporating power of your engines?

It does not exceed 100 cubic feet an hour.

5897. You think that there would be no difficulty in making a fire-box sufficiently large to give the requisite evaporation?

I think not; there is no difficulty in making the fire-box double the size than it is at present.

5907. Have you used an indicator upon your engines while in motion?

I have used one, but I have never placed much dependence upon the results; the vibrations of the index are so rapid that I have never been able to come at any accurate result.

Mr. E. Woods.

5997. Will you state the advantage that you would gain by larger wheels?

The only advantage I see is, that you would have fewer turns of your wheel in a given space, and the derangement of the machinery would be smaller; but still the machinery is so well arranged, that there is no great objection to be taken on that score.

5998. The strokes of your piston would be fewer?

Yes.

5999. And your steam would be better employed?

I do not think it would.

6000. It would make a difference in the amount of shocks?

Yes; that is the only difference it would make. I think the velocity of the steam entering into the cylinder is so great, as compared with any velocity that is given to the piston in practice, that little or no loss of power would arise from that cause.

6005. The Gauge is no wider than is necessary for the power?

Comparison of Gauges.

I think you might get the same power, and do get the same power, on the Narrow Gauge with the engines that are used. As I said before, the power of the engine must be limited, in the first place, by the weight that the rail will bear; and, in the next place, by the adhesion of the wheel to the rail: there is no increasing the tractive power of the engine beyond its adhesion.

6008. Knowing the construction of the Great Western Railway, do you think it is able to sustain heavier engines than the Narrow Gauge?

I should think it is not able to sustain such heavy engines.

6009. But its engines are heavier at this time?

Yes; but I do not think the rails are equally qualified to sustain that weight. I think there must be more deterioration of the rails going on on that line than there is on the Narrow Gauge line.

6010. Do you think that no security is given by the longitudinal bearings and timbers?

I think not; I think the transverse sleeper is the most durable and the most secure.

5939. Have loose boxes ever been tried within your knowledge?

Yes; the colliery of Messrs. Bourne and Robinson, close to the Manchester and Liverpool Railway, had some waggons fitted on that principle, with loose bodies, and they were abandoned.

5940. Were they abandoned from any inconvenience found to result.

I think they were; they were found to be troublesome.

5943. To what places was that coal conveyed?

It was conveyed from Rainhill to Liverpool, about 10 miles.

5944. For the use of the town of Liverpool?

Yes.

5951. Are you aware whether loose boxes are used for any other purpose upon the railway?

No, they are not used at all upon the Manchester and Liverpool Railway at present.

5971. You never mix goods for Manchester with goods for Leeds?

No; they are all loaded on waggons which go through.

Mr. E. Woods.

5972. You do not break bulk on the journey?

We do not; we did for a short time after the opening of the junction between the Leeds Railway and the Liverpool and Manchester; that was done for this reason, that the Leeds and Manchester waggons were longer between the wheels than ours, and they would not turn on our turn-tables at the station at Wapping; they were therefore stopped at Manchester and loaded on the Manchester waggons; but there was an immense inconvenience resulting from that.

5973. Did you yourself witness that inconvenience?

Yes.

5974. That was equivalent to a change of Gauge?

It was.

5975. Can you describe at all the nature of the inconvenience or its amount?

Perhaps I can hardly describe the extent, but I believe it very much limited the traffic; we were obliged to refuse goods in consequence of that interruption, and they went by the water conveyance.

Maj.-Gen. Sir J. F. Burgoyne.

November 19, 1845.

MILITARY EVIDENCE.

MAJOR-GENERAL Sir JOHN FOX BURGOYNE, K.C.B., Inspector-General of Fortifications—lately Chief Commissioner of Public Works in Ireland, and also one of the Railway Commissioners for that Country.

The military uses of railways.

6346. You are probably of opinion that the facility of moving artillery, cavalry, and infantry, by railway, might be, in case of war, essentially conducive to the national defence?

No doubt of it, of very great importance. I look upon the whole safety of the kingdom to depend upon railways. Looking at the facility there is now for making incursions upon the coast, with large bodies of men such as the French have, nothing but the power of concentration which the railways would give could enable you to resist successfully; and I think you will thus be able successfully to counteract, with the aid of a few other means, the apprehensions of invasion from the power of steam vessels. I quite understand Sir Willoughby Gordon's reasoning about the difference between the present and former times. Formerly the apprehension was always upon the south coast of England, and it was very necessary there to have the troops stationed, so that they could be within reach of every part, by the then mode of communication, which was by ordinary marching, therefore you could not afford to have them above three or four days' distance; but now you would have your troops away 200 miles in the north, and you would bring them down, within 24 or 48 hours, to any part where there was a threatening;

Railways afford means to successfully resist innovation.

Formerly necessary to have troops within three or four days' marching distance. Now you could have them 200 miles away in the north.

Maj.-Gen. Sir J. F. Burgoyne.

giving you that power, the great advantage of which is well known in military tactics, the power of concentrating upon any given point in a short time. For you could concentrate nearly all the forces of England before the enemy could go through the operation of actually landing 20,000 men; for we know that the operation of landing a large body of men, under every advantage which the British navy afforded us, was very serious: it took days and weeks to effect it, with all the equipments. I do not believe any other power is at all aware, as we are, of the difficulties of landing troops, because we have tried it over and over again, which they never did; and we have found by experience, that it was attended with very great difficulty, and took a very long time. The whole question of war depends upon the general who can concentrate his troops with the greatest rapidity, and in the greatest numbers, upon a given point of importance; and if you can get down your men from the north faster than the enemy can land them upon the coast, of course you have every advantage.

Could concentrate all the forces of England before the enemy could actually land 20,000 men. No foreign power aware of the difficulties of landing troops.

Break of Gauge.

There would be one very serious objection to a break of Gauge, which is, that it would require a double stock of carriages, and the carriages would always be a great difficulty. I imagine that you could find on any railway locomotives enough to move 100,000 men in a short period, but that you could not find carriages. The carriage must be constantly employed from the moment it has the soldier in it till the moment he comes to his place of destination.

6348. Supposing that Bristol, or the district around it, were the point threatened, and that it was desirable to bring there all the troops that you had in the north, they would come by the Narrow Gauge lines, and would concentrate at Rugby, bringing perhaps the whole stock of carriages from the north, and it would be impossible to find upon one line of railway, which would be the

Great Western, the quantity of carriages necessary to carry them forward? Maj.-Gen. Sir J. F. Burgoyne.

Precisely; that would be a very serious matter. I have made a little rough calculation about the carriages. Supposing a soldier, with his equipments, to be somewhat about 2 cwt. Supposing the man to be 11 stone and a half, then his arms and accoutrements and his pack, and three days' provision, which would be necessary in case of emergency, I do not think would come to much less than 60 lbs. in weight. That is rather more than 2 cwt. Suppose we take 38 tons for 360 men, in 12 carriages holding 30 men each. One carriage for the officers, reckoned at 2 tons, and one carriage for the officers' horses; it is very desirable that the officers should be mounted immediately they come to the end of the journey; and one carriage with baggage, say 3 or 4 tons. That would be a total of 45 tons in 15 carriages, which, I suppose, one train would be equal to, and that one locomotive would convey such a force at the rate of 25 miles an hour. I presume it would carry 45 tons gross weight in 15 carriages at least 25 miles an hour. Then I say 10 such trains would convey 3,600 men, and I imagine, as far as the locomotives go, they could be sent in pretty rapid succession. But for those 3,600 men it would require 150 carriages, and I think in carriages for troops there should be some particular adaptation for them. If you have troops going a short distance, they carry their muskets between their legs, and their packs just in any way they can. But when you are carrying them considerable distances, when you carry them in the night, in order to prevent injury to their equipments, and to enable them to travel with facility, and to be fresh at the end of the journey, it would be better if the carriage was adapted for that particular purpose; if there was some mode in which they could stow their arms, and where their packs would go; and I imagine that that would not be difficult. But if you had to move large bodies of troops, and it came to be a matter of very great importance, as it might in case

Difficulty of finding on one Railway carriages enough to move 10,000 men.

10 trains of 15 carriages to convey 3,600 men.

Maj.-Gen. Sir J. S. Hungerford.

Suggests carriages adapted for soldiers' arms and packs.

of invasion, it would be very desirable to have carriages particularly adapted to the purpose, or at least some mode of converting any ordinary carriage easily into one adapted for troops. You have your trucks, you have your wheels and axles, and you have your platforms, and the only question is, what superstructure to raise upon them, which probably any common carpenter would be able to do in a short time. Still the number of carriages would be very great for 3,600 men; 150 carriages would be wanted, of which 120 ought to be peculiarly adapted to soldiers. Now those carriages would be required from one end of the journey to the other, if they are going from Edinburgh to Portsmouth, the carriage must be occupied the whole time. Then 3,600 men is but a small force to what I contemplate would be required under such circumstances. In case of any future war the mode to oppose the power of steam would be this: you would have an immense militia organised all over the country. I believe, with volunteers, it consisted of 300,000 or 400,000 men at the time of the last war. Then there should be the power of carrying 100,000, or 150,000, or 200,000 men down to the coast at any time. Then you see what a number of carriages it requires to carry so large a body. Still it would be very desirable, with a view to defence, to have them all ready, and I do not see that it would be attended with very much expense, because everything of that kind would be applicable to the ordinary purposes of traffic in the mean time.

Carriages would be required from one end of journey to another.

Power required for carrying 100,000 to 200,000 men.

6349. You do not conceive they would be maintained as Government property in the stations?

No, I do not see that it would be desirable to make such great preparation, at very great expense, for a case of emergency, which may not occur for years, if ever it occurs; but the great object is to find the means of adapting the ordinary carriages to this service. It would be desirable, if possible, for Government to induce Companies to have a large stock of

Maj.-Gen. Sir J. F. Burgoyne.

those things, and trucks and axles. Now if there was an universal Gauge, of course it would be very greatly facilitated, because every carriage would be universally applicable, but where there is a Break of Gauge it would require a double stock.

6350. Is it likely that cavalry would be carried in great numbers by railway?

I should think not; 90 horses would require 30 carriages; 900 would require 300 carriages. I do not apprehend that they could do much in that way. But I think you could carry the artillery horses by railway. A brigade of artillery would require 120 or 130 horses. A brigade of artillery is such a powerful weapon, that it might be worth while to adapt carriages to carry a force of that kind; for if you carried the artillery and their harness, you could find horses all over England that would be perfectly adapted to artillery, though they would not be adapted to cavalry, because any cart-horse or carriage-horse would be adapted to artillery. There is another very great facility that railways give, with regard to military operations, which is in carrying camp equipage. In case of war, camp equipage is of the greatest importance, and the carriage of it by ordinary means is very difficult, but by railway you would carry it with the troops very easily, and you would form an encampment very easily in a very short time. Of course that would be affected by a change of Gauge, having every article to shift from one to another. As regards the lines, with respect to which a question was put to Sir Willoughby Gordon, where there is a break, I should attach much less importance to those on the south, that are parallel to the coast, than to those that come down from the north. All military operations are important in proportion as they came from some concentrated point and diverge to the outer surface, the connecting links nearer to your central situation are the more important, and the further distant they are the less important they are.

Railways facilitate carriage of camp equipage.

Affected by break of Gauge.

6351. Is not this a possible case in the event of an invasion, that a steam fleet might threaten first one part of the coast and then another part of the coast, and, in that case, a rapid communication between the troops on the coast line would be necessary to meet that?

It would not be necessary to make a movement parallel to the enemy: it would be better to go to a central point and come down upon them more particularly with the facilities that the railway would give you. You would have the railways concentrated near London, and then again at Birmingham, &c.

6352. In a military point of view, does it appear important that the railways should be connected in the neighbourhood of London: for instance, the Birmingham Railway and the Great Western Railway?

I do not see that that is particularly necessary. I do not see why a break would be more inconvenient there than anywhere else. Of course, it would be of advantage if they were connected; but I am not aware of any particular advantage in it. The same rule applies to railways which applied to roads. The military principle was to have a connexion in the rear of the lines you are occupying, but not along the front. Then there is another great advantage in the railways in defensive warfare, which is, that the parties who are defending themselves, who are resisting invasion, have the use of the railways to the last; whereas, if the enemy gets possession of it, it is of no use whatever to him. Now, in the case of ordinary roads, when an enemy got possession of a road, it was of great service to him; he immediately run along it till he got to the next point of opposition. But when he gets possession of a railway it is of no use to him at all; he has no carriages and no locomotives; but you have the use of them, on the contrary, till the last moment. I look upon railways to be important mainly for defence, and

Railways of no use to enemy if seized.

Maj.-Gen. Sir J. F. Burgoyne.

I think steam generally is chiefly of advantage in favour of defensive power. You can never go and blockade a distant port as you used to do. You could not get a few steamers along the coast of America to compete with what they could let out upon you with a very inferior force. It would be out of the question to blockade distant ports as you used to do. But I think that by taking the precautions that are likely to be taken with regard to the immediate defence of the coast, and using the advantage of concentration by railway, it would give you great power of resisting against every species of invasion.

Steam better for defence than offence.

6353. For the defence of Plymouth it is of greater importance in your view that there should be an uninterrupted line of the same Gauge from London to Plymouth than that there should be a coast line from Portsmouth to Plymouth?

I think, much greater.

6354. Although there would probably be a large body of troops concentrated at Portsmouth?

Decidedly. I should expect all the reserves to be a long way in the rear, always having the facility of that rapid communication to various points. I would never trust in the front more than what were necessary for immediate defence. I do not imagine that at any of those places on the coast you would have troops for general application; it would only be for the immediate defence for a short time. The great reserves would all be in the interior. You would have forces adequate for a short attack, and you would never be tempted to move them away, because you might compromise the safety of the place itself.

Great resources in case of invasion would be in the interior.

6355. The way in which a coast line would be useful would be that, in the event of your sending a large reserve to Portsmouth, and not finding them

Coast lines.

Maj.-Gen. Sir J. F. Burgoyne.

necessary there, you might then take them along the coast line to Plymouth?

I would rather trust to the interior. Along the outer circumference troops attempting to assemble might be met by the enemy and opposed in detail, whereas, from the interior, they have the advantage of concentration on their side, and may direct their masses on inferior forces.

6356. Does anything further occur to you in respect to this question?

No great danger of Railways being broken up.

I think that the point that Sir Willoughby Gordon mentioned about the security of railways in case of insurrection is of very great importance. It is one that has always struck me with reference to the danger of having the railways broken up. If you had any apprehension of anything of the kind, you would have a flying corps upon the railway which would run from one place to another; and anybody that attempted it would get into a great scrape; for you would be upon them before they could be aware of it. They might do partial mischief for a short time, but they could not keep any permanent hold of the thing, or do any such mischief that your own people would not be able to repair in a short time.

General Sir J. W. Gordon.

Nov. 19th, 1845.

MILITARY EVIDENCE.

(Opposed to Break of Gauge.)

GENERAL Sir J. WILLOUGHBY GORDON, G.C.B., and G.C.H., Quartermaster-General.

Military Uses of Railways.

6322. As Quartermaster-General you are aware probably of the extent to which railways are used for the removal of troops in this kingdom?

In three years and a half, 212,000 people moved, soldiers, women and children.

Yes; perhaps the best answer I can give to that will be to state the number of troops that have been moved by railways in the course of three years and a-half, ending the 30th of June last. I will leave the return upon the table, by which the Commissioners will see that there have been moved in that time 212,000 people, of which 9600 were women, and above 11,000 children, and without any reported accident, which is a degree of security, I believe, unknown to any other mode of conveyance.

The return was delivered in, and the following is a summary.

	1842.	1843.	1844.	To June 30, 1845.	Total.
Officers . .	1,751	1,502	1,419	657	5,329
Men . . .	62,012	52,911	48,516	22,754	186,193
Women . .	3,211	2,494	2,309	1,663	9,677
Children . .	3,373	2,920	3,031	1,900	11,244
Horses . .	113	..	169	96	378
General Total	70,460	59,827	55,444	27,070	212,801

6325. Do you imagine that in the event of this country being at war with France, the railways of this kingdom could be advantageously used in the national defence?

Certainly. The effect of rapid communication by

General Sir W. Gordon.

railway, speaking militarily, is that it enables you to do with a small army the work of a large one.

Break of Gauge.

6326. Do you conceive that such utility would be materially diminished by breaks of the Gauge in the line of route involving a transfer from one set of carriages to another?

A break of Gauge the same inconvenience as a ferry.

Certainly; the practical result would be the inconvenience of a ferry, because at every change you must disembark your troops, men, women, and children, and baggage, and not only would time be lost, but there would be no small difficulty in knowing where to put them; you cannot cover large bodies of men without due notice, and I should think the very greatest inconvenience would result from such a thing. When troops are collected together, a great deal of detail is necessary with respect to their arms, their appointments, their ammunition, and their baggage, and when all that is carefully stowed away, it would be productive of very great inconvenience to change it from one line to another upon a different Gauge.

6329. Or from one set of carriages to another at the same station?

Yes; that is what I mean.

6330. It would involve the unpacking of the whole of that part of the train?

It would.

6331. How do you think it would affect the removal of cavalry?

Moving Infantry cheaper than marching.

In like manner, when cavalry are moved by railway, which is very rarely done. You will see by the return that it has been done; but it is very rarely done because it is expensive. In moving infantry it is not expensive; it is cheaper than marching; but when cavalry are moved, the horse is put into the horse-box as the man dismounts him, and he is

tightly bailed up; that is necessary, and he comes out of the horse-box, after a movement of 100 miles, just as fresh as when he went into it. It is exceedingly convenient; but as I said before, it is very rarely done, except the public service requires rapid movement, on account of the large expense. General Sir J. W. Gordon. Moving Cavalry convenient, but expensive.

6332. You have not found the removal of infantry by railway more expensive than ordinary marching?

No; the removal of infantry is cheaper; because a railway journey which would occupy the time of nine hours, for example, from here to Manchester, would take 17 marches: then the expense of the marching-money put against the expense of the railway makes the expense of the railway less. But a horse costs no more marching than he does in the stable, and therefore it is only the difference of the man; consequently the expense of moving cavalry by railway is very great.

6333. Do you think circumstances might arise with reference to the national defence which might render it desirable that the Government should keep at some of the principal stations a particular kind of carriage and horse-box for the removal of cavalry?

Possibly in such a case as that, carriages both for men and beasts might be multiplied; because I have sometimes found that in moving large bodies of men they wish for notice to collect their carriages. In such an extreme case as that it might be desirable.

6334. If those carriages were subjected to a break of Gauge, would not the great object of such an arrangement be very much defeated? Break of Gauge.

Very much. I can conceive no greater inconvenience than shifting from one Gauge to another.

6336. Will you have the goodness to look at this map: it is understood that there is to be a line

of railway from Southampton, passing to Dorchester, and from thence on to the west of England. Now, according to the intentions of the different Companies, the line from Dorchester to Yeovil is to be a Broad Gauge line, and the line as settled from near Bridport, would be a Narrow Gauge line; so that there would be a break of Gauge at Dorchester, a break of Gauge near Bridport, and a break of Gauge near Exeter, if the line going to Cornwall should be a Narrow Gauge line?

Troops would be stationed in a central place, in case of invasion.

Nothing could be more inconvenient. At the breaking out of the last war, when the French were assembling large bodies of troops with the view to come over, as they probably and certainly, I believe, would do again, you had large bodies of troops quartered at different parts of the coast, which was very inconvenient and very expensive. Now it would not be necessary to do that; you would probably concentrate them in some central place, and move them from thence by railway.

6337. You mean that they would not be concentrated upon any point of the coast?

No; at the breaking out of the last war, you had a large division of the army in Essex; you had another in Norfolk; you had another in Northamptonshire, and so on northward. You had a very large one in Kent; you had another in Sussex; you had another in Hampshire; and you had one in Devonshire; all of which were separate and distinct corps, and could not be removed but at great expense of time and labour. Now in the event of similar circumstances of hostility with France, it would be much better to concentrate all those troops in some central point, such a central point as might be thought best, and from thence they might be conveyed by railway to any part of the coast where their services were most required, to and fro with very great rapidity and certainty.

6338. Taking the great lines as radii from that focus?

Yes; the focus might be wherever it might be thought best. You might consider which was best, with a view to ammunition, with a view to proximity to an arsenal, with a view to provisions, and with a view to the troops being quartered; they would go backwards and forwards without difficulty.

6339. Of course it would be a great object that all the radii proceeding from that focus should be upon the same Gauge, because otherwise the cross lines would produce great difficulty?

No doubt about it.

6340. Is it your view that the place of concentration would probably be a fortress upon the coast, or a place in the interior?

It should be either near* the metropolis, or some place in the interior. All these things depend so much upon circumstances, that it is difficult to name with precision any place of the kind, without having before you all the matters connected with it.

6341. In fact, there might be more foci than one?

Just so; there were a great many things done in the last war that were thought very absurd afterwards, but which are extremely useful now. For example, all those martello towers upon the coast would be very useful now; they would be a great protection for the coast trade, or against steam-boats.

* According to the plans deposited at the Board of Trade, troops moving from Reading along the South-West Coast to Bridport and Plymouth would encounter four breaks of Gauge.

Mr. R. Down.

November 13, 1845.

Mr. R. Down, Contractor on the Bristol and Exeter Railway.

Break of Gauge. Remedies.

6295. Have you any experience in the system of moving coals in loose boxes?

At the next wharf, about three miles and a half from me, the West of England Company have loose boxes. We are 45 miles from Exeter, and they 48½.

6299. The other Company to which you allude attempted the use of loose boxes?

Loose boxes.

Yes; but that was not to move from one Gauge to another; it was to send over to Newport and get the coals put into those loose boxes, and lift them into the vessel, and lift them out again. They thought they should prevent the coal being broken; but they had to come into the river without any quay walls, a dirty, muddy river, and they had to lift those boxes out of the vessel into barges to come through the locks, and lift those boxes again by a crane from the barges to the trucks, and they found it so troublesome that they have abandoned them.*

6305. Did you find that they lost their shape?

No, they did not appear to lose their shape; but the manager wished that they had been done away with long ago.

* 6799. Do you know instances in which similar mechanical contrivances have been applied to similar purposes?

Yes, on the Bristol and Exeter line we carry on a large coal-trade entirely in boxes, which come from the vessels, and are lifted on the platforms of our vessels, which is done not by the Company, but by the coal-merchants, who have a large business there upon the line; and I see no difficulty resulting from it; and the mechanical arrangements of such a thing, if it came upon our line, is easily conceived as soon as necessary; I do not understand the difficulty which has been supposed to exist.—*Mr. Brunel, H. C. Committee, Oxford, Worcester, and Wolverhampton Bill.*

6306. How long have they abandoned that system? Mr. R. Down.

I think they may work a truck or two now. I do not think they have got the whole of their trucks boarded up now, but they are rather slack at this time. Loose boxes nearly discontinued.

6307. How long is it since they commenced the loose-box system?

I suppose 15 or 16 months.

6308. Then they had about a year's practice of it?

Yes.

6309. Was it to any very great extent that they used the loose boxes?

I should think they sent 100 tons a-day.

6310. And they intend entirely to give them up?

Yes; I have not seen a box now used these two months. I think they have got as many as 40 trucks with the sides made up now.

631. Do you think that the objections that apply to the use of the loose boxes at that particular place would apply to any change from the Narrow to the Broad Gauge, or from the Broad to the Narrow Gauge in a line of Railway?

I should think it would; it would take up so much time to shift them from one Gauge to another. Great loss of time in shifting boxes if a change of Gauge.

Mr. T. Jackson.

December 21, 1841.

Mr. Thomas Jackson, formerly Contractor for the maintenance of the permanent way of the London and Birmingham Railway.

6494. An embankment provided for a 4 ft. 8½ in. would require widening to the extent of nearly 2 ft. more on each side to make a 7 ft. road. The same width that now exists on the outside of a 4 ft. 8½ in. railway, would be needful on the side of the additional rails.

6498. It would be attended with risk to the public to interpose between the up and down lines of the Great Western Railway two additional rails, so as to have eight rails upon the same embankment and cutting; it would involve a greater number of points, crossings, and switches, and the maintenance of an additional road. If I were called upon to enter into a contract to maintain a road proper for conveying the public over it by trains, I would much rather maintain one road down and the other road up, than I would have two roads down and two roads up; therefore, as a general measure, I should not be disposed to recommend that a railway should have a sufficient number of rails to take both the Broad and the Narrow Gauge. It would very considerably increase the expense. Wherever it can be done with one pair of rails, either 7 ft. or 4 ft. 8½ in., it is much preferable in point of security and economy, and certainty of performance.

6500. Can you form any estimate of the difference it would make in the amount of your contract?

Supposing the line cost 300*l.* a mile per annum of finding the rails and chairs, and maintenance of permanent way; under the contract I had with the

London and Birmingham Company, if a double rail was laid down, I should be inclined to think that 100*l.* per mile would do it. Mr. T. Jackson.

6515. Supposing there exists a Broad Gauge line—say the Great Western—and they wished to put into it the narrow way, how would you do it?

I should introduce longitudinal sleepers parallel to those that are already laid down.

6523. Do you think that altogether it would be better to avoid the intermixture of Gauges as a matter of safety?

Most unquestionably. It would be accompanied by a great share of risk and expense attached to it. Risk and expense by intermixture of Gauges.

6523. By risk, do you mean a risk to the trains running?

I mean a risk of incurring danger and expense in upholding. I see no inducement, or price which would induce me, to enter into a contract to maintain both roads, were I to be responsible for accidents arising out of the same to the passenger trains and goods trains.

Mr. George Bodmer, Manufacturer of Locomotive Engines.

4175. What is the special disadvantage which you consider to arise from the too great length of the tubes, or too great narrowness?

If I am not wrong, it must be this: suppose the tube is so long as to take up the heat which is generated, or rather which goes into the tube before it comes to the end, if the heat in the tube goes below the heat of the water in the boiler which you require, I think, then, the tube is too long. I think, if the heat from the tube goes out at a higher temperature than that of the water in the boiler, it cannot be too long.

4191. In your opinion, will the extension of the fire-box in the longitudinal direction obviate the objections which have been made by Mr. Gooch to the too small heating surface?

I can state something which has been tried for several years in common grates; we try to increase the length of fire-grates, and make them narrow, and we find that they work much better than a broad fire-grate. (*The Witness produced a drawing of fire-grates, and explained it to the Commissioners.*)

4210. So that you have in the whole four powerful cranks and six eccentrics upon the axis?

Yes; that certainly makes the engines so much the more complicated.

4211. But there is sufficient room upon the axis?

We find plenty. I had some difficulty in working it out, but now we have plenty of room.

4212. And, upon the whole, would you wish the width of the Gauge to be increased?

If it was to be done now, I should say yes, six or eight inches; but as we have gone so far I should say it would not be worth the expense of an alteration.

Mr. George Bodmer.

4215. If you had a little greater width of Gauge how would you employ it?

It would give me the means instead of flat slide valves, of making them cylindrical, which I am doing now with outside cylinders.

Mr. Edward Bury.

August 15, 1845.

MR. EDW. BURY, Manufacturer of Locomotive Engines for the last 17 years.

Opinion of Gauge.

1150. Are you of opinion that the 4 feet $8\frac{1}{2}$ inch Gauge gives sufficient space for the machinery of a locomotive engine to have all the power that is necessary to work trains at high velocities, or for working luggage or goods trains of great weight?

I think a line of rails would be better if wider; I think 4 feet $8\frac{1}{2}$ inches is too narrow for the engines and carriages, and all the machinery working on the rails.

1151. What additional space would be required for your locomotive engine?

A very few inches for the locomotive engine would suffice. I think if we had 6 or 8 inches, it would be sufficient for anything we wanted.

1230. You have mentioned that there were some inconveniences in the construction of engines of 4 feet $8\frac{1}{2}$ Gauge, which in your opinion would be removed by increasing the Gauge 6 or 8 inches?

Yes; a very small addition would give great accommodation in the construction of the engine.

1231. Having considered this matter practically, will you state, as specifically as you can, the inconveniences that exist in the engine; are you obliged to make any parts too weak, for instance?

We are not obliged to make any parts too weak;

very accurately to dimen-

you cannot keep clean

very well to clean; we do

convenience small?

very considerable indeed, and
known by parties who have to

ulties are overcome by the
is good?

ngine would be far better if the

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ently travelled by the express trains
Birmingham. I find very little
We tried with one of the new
we could do it, and we took the
and thirty-five minutes from Euston
ation at Birmingham. I went down
with Wolverton upon the engine. I
ine is almost steadier than any other
better screwed up. Everything is

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speed at which we have arrived is
effected with safety. I do not know
in the winter, during foggy weather.
at high velocities in fair weather,
before him; but what we are to
winter, during foggy weather, at
do not know. I think the public
serious accidents.

of express trains?

Mr. Edward Bury.

1102. Do you imagine that the state of the road is such as to justify a higher rate of speed than you have hitherto attained?

No; I think the securities for the rail are not sufficient.

1109. I think the injury to the permanent way will be in proportion to the speed. That which would do at twenty miles an hour will not do at forty, for as you increase the velocity you must increase the security.

1112. Do you imagine that greater speed is to be attained on the Broad Gauge than on the Narrow?

Yes, for this reason; the speed depends on the ratio of the stroke to the wheel; they may get a longer stroke, and a larger wheel on the Broad Gauge than we can, but I think the Narrow Gauge will give a great deal faster speed than can be useful. It would entail the necessity of making the Great Western engines heavier if you gave them larger wheels.

1114. Do you imagine that the permanent way of any railway is at present such as to justify larger engines and greater speed?

I think not; I have not seen any such.

1115. But if the permanent way were such as to bear an increased speed with equal facility, could you get that increased speed better on the Broad Gauge than on the Narrow Gauge?

You may get a larger engine.

Construction of engines.

1192. Does the steadiness of the engine on the rails become increased, in your opinion, by increasing its length?

Yes.

1195. I think in the 4 ft. 8½ Gauge there is space

Mr. Stewart Harris.

enough for very great power. It is almost impossible to say what load an engine may be made to take on a Narrow Gauge, but I certainly think that, for the ordinary traffic of the country, an engine on the Narrow Gauge may be made of quite sufficient power, both for velocity and for passenger trains, and for luggage trains.

Break of Gauge.

1126. At what period did you commence running your carriages through?

A few months after the two lines opened; after we opened through to Birmingham.

1127. It was a long time subsequent to the opening that we ran the carriages through on the Midland Counties.

Remedies.

1128. Have you at all contemplated the effect of having to convey coals and goods in loose boxes, if your line becomes connected with a Broad Gauge?

I do not think it could be done. It is one of those notions which is just a fancy for the time, but it never could be done in practice. On the Liverpool and Manchester, I have seen loose boxes on the railway carriages for the purpose of trans-shipment to the carts.

Loose boxes.

There was a delivery of coals at Crown-street, and to save the expense of reloading, the boxes were laid loose upon the waggons or trucks; it was attended with great confusion, and a great deal of expense, and it was given up. The boxes were made to hold about 30 cwt.; they were fixed on rollers; the frame of the waggon had a little railway upon it, upon which these boxes could be rolled, and they were drawn off the truck on to the cart wheels, where there was a little corresponding railway. It was always attended with a great deal of trouble and inconvenience; and was eventually abandoned. It was tried a great length of time, for they wished to accomplish it if they could, but it was given up.

1131. Do you know the reason that it was given up?

The trouble of keeping the things in order, and it was found less expensive and inconvenient to reload or unload the ordinary railway coal-waggons into a common cart.

Remedies.

1132. Do you apprehend that would be the case at Rugby, with coals going to Oxford on the Broad Gauge from the Narrow?

I think it would entirely prevent the coal traffic from being carried on. I do not see how it is possible to avoid it, because the expense of shifting coals from one waggon to another would be very considerable, and the detention of the waggons would be very great.

Loose boxes.

1133. Do you think that a loose box being lifted off its carriage, and put upon the Broad Gauge, would not answer practically?

I think it would not.

1134. Do you think a carriage could not be made strong enough to bear the transfer?

In giving these opinions I speak relatively to the cost. You may accomplish anything, if the expense is not to be considered, or if it is not to be known what is the expense; but if it is to be a question of economy, I should say that such an arrangement could never be carried out. Of course the coal owners will carry their coal at the cheapest rate. If a great expense is involved in the transfer of one carriage to another, they would have recourse to canals in preference to railways.

Loose Bodied Carriages.

1137. Do you think it practicable to build carriages to ensure safety to passengers if the body were removable from the under frame?

It might be done; but I should say it was a very injudicious way of doing it. We cannot tell to what extent or how far the ingenuity of man may be carried, but it does not appear to me to be the right course.

Mr. Edward Bury.

1138. Do you think it would endanger the public safety?

Safety.

I think so; it would be attended with a great deal of inconvenience, and a great deal of delay.

1139. On the Paris and Rouen Railway, it has been stated that a transfer is effected by the body of the diligences being lifted from the under carriages and placed upon railway carriages, and that at the end of the journey they are re-transferred to road carriages?

When first the London and Birmingham Railway opened to Denbigh Hall we did the Post-office work to that place. The mails were loaded at the Swan-with-two-Necks; we put them on a truck at Euston-square station, they were carried down to Denbigh Hall, they were then drawn off the trucks and put on the road, and they went to Birmingham. It was not worth while putting them on at Rugby; but it was attended with a great deal of inconvenience. I think we had eight or nine mails in that way every night.

1140. In the case referred to they leave the carriage behind, and merely shift the body, and the body is then placed on the railway carriage, performs its journey, and at the end of the journey it is again put on the road carriage?

I should say that such an arrangement was perfectly and entirely impossible where the traffic is to any extent: we could not do it on the London and Birmingham Railway. I am quite certain it could not be done with a heavy traffic.

1141. Supposing that one half of the Midland Counties trains were to be transferred in that way at Rugby, do you think it would be attended with great delay?

No doubt it would.

Mr. Edward Bury.

1142. Do you think that at the high velocities now used it would be attended with risk?

Very great risk. You would lose the advantage of the high velocity, because the delay would be a great deal more than travelling in the ordinary course at a moderate velocity.

1158. In the event of the loose box system being adopted throughout the country our present waggons would become entirely useless.

Narrow Carriage to run on Broad.

1224. Are you aware that it has been proposed to use carriages with shifting wheels to run on the Broad Gauge or the Narrow Gauge?

I have understood that some such notion has been broached.

1225. Are you able to give an opinion at all upon its practicability?

I should give a very decided opinion against it, upon the ground of the difficulty of keeping the securities always right.

1227. Are you of opinion that everything that requires the hand of a man on the spot to arrange for the train is always a matter of danger, if of a mechanical description?

Loose Wheel tried and abandoned.

Of the notion of having shifting axles and sliding rails, and other things of that kind, I can scarcely speak, for it seems to me to be quite wild. Trials were made some years ago to allow the wheels to adjust themselves on curves; one end of the axle was made of a hollow tube, and the other was made a spindle to fit in, so that they should adjust themselves on the curve; but it was abandoned, for they never could keep the thing right.

1228. Can you state where that was tried?

In the United States.

Mr. T. J. Buckton.

August 28, 1845.

Mr. Thomas John Buckton, Secretary to the London and Brighton Railway.

Break of Gauge.

1945. I have had experience in the shipping of goods. At one time I had the superintendence of the docks at Hull. There was a tram road there worked by horses; and my own impression is, that any change of carriage involves a very considerable expense; that we can seldom put that expense at less than from 8*d.* to 1*s.* 6*d.* per ton, according to the kind of goods and the facility of moving them; that in many cases that involves the necessity of counting and often weighing; that the responsibility is changed from one carrier to another carrier; that in the event of loss or accident the owner of the goods has great difficulty in identifying the party, and knowing where the damage is done, each party being anxious to shift the responsibility to the other; and upon the whole my impression is, from a knowledge of the trade that exists between Liverpool and Hull, and that direction, and from what I have seen here in the south, that it is very necessary that the goods should be conveyed, as we say, in one bottom.

Expenses of transfer from 8*d.* to 1*s.* 6*d.* a ton.

1951. I have a recollection that upon the Hull and Selby line a very serious accident occurred in consequence of a large piece of iron machinery falling off the line by not being properly secured.

1952. Was that piece of iron lashed to a certain extent?

Yes; but the difficulty is in getting those things properly attended to.

1953. When the number is very considerable, is the chance of inattention greater?

Decidedly; particularly where there must be considerable despatch. Despatch is the pressing point in business. Great anxiety exists to lose no time in transferring, especially with valuable goods.

MR. JOHN GRAY, Resident Engineer and Locomotive Superintendent of the Brighton line.

2138. Do you conceive that an engine made with an outside cylinder has a greater tendency to leave the rail at high velocities? Construction of Engine.

Certainly; there can scarcely be a doubt about it.

2140. Have you yourself witnessed any accident of that kind—the actual running off the road, without any cause beyond that of speed?

I do not know that I have. I know of one case of an engine going off on the Liverpool and Manchester line, it might be said apparently without any cause; but one of the axle-boxes had been heated, and it was found to have thrown the axle half an inch out of the square; that was all in favour of throwing it off outside of a curve, and it did actually go off in that manner.

2166. Does the outside cylinder give you a greater facility of oiling and repairing the gear?

A little; we have very free access with the arrangement of the engine that is now beginning generally to be introduced. We can get a man's head and shoulders through, and up to the boiler, and between the crank axle and the fire-box; we consider it is better sheltered inside from the weather than outside, in the cylinder especially. The cylinders are more exposed, and the quantity of cooling surface is amazingly great in the late outside engines; and I think the odds are very much in favour of the inside arrangement with the crank-axles.

2173. Does not an oval boiler lift the centre of gravity a little up?

Yes; I really do not care much about the centre of gravity. You should give it a good width of bearing

Mr. J. Gray. upon your outside spring, keeping it as steady as possible. In the passenger engines on the Hull and Selby the distance from centre to centre of the outside bearings is 6 feet 6 inches. On the crank-axle where you have a sort of neutral axis in the engine, with very little power over the stability of the engine, there we put the inside bearings exclusively. It requires pretty nearly one-sixth more diameter, to stand equally well, for outside bearings than it does for inside bearings.

Opinions on Gauge. 2167. Do you imagine it would be desirable, supposing railways were about to be constructed in a new country where none existed before, to increase the Gauge from 4 feet 8½ inches?

It certainly would be desirable. I could make an engine that would be much more durable than the present engines with the Wide Gauge.

2168. As a locomotive manufacturer, what, in your opinion, is the minimum of width to suffice all purposes?

Everything being untrammelled in a new country, I should not say under 5½ feet or 6 feet; I think that would amply suffice; I think 6 feet would be quite the maximum.

Construction of roads. 2188. Have you at all considered the question of the transverse and longitudinal sleeper?

I have had a great deal to do with them on the Hull and Selby, where there are about 18 miles of the longitudinal, and the remainder of the road is on cross sleepers.

2189. What is the result of your observation upon that line?

Decidedly in favour of cross sleepers.

2189. Will you be good enough to assign the reason?

There is a difficulty in keeping the tail perfectly in

Mr. J. Gray.

contact with the timber. You want it, as it were, pressed on the timber with a constant pressure, nearly equal to the pressure coming upon it, to prevent a motion taking place. That is impossible by any sort of fastening, unless it be one continuous fastening almost every 6 inches. As soon as a shower of rain occurs, the water gets in between the rail and the sleeper, the pressure of the wheels produces a sort of hydraulic action, and it is forced out; each wheel forces it out against the opposite one, and it forms a complete slap-dashing machine. I have seen the engine going out almost as clean as a new pin, and before half an hour had elapsed you could scarcely see a clean spot upon it.

2197. When I first went to the Hull and Selby line I had a more favourable opinion of the longitudinal bearings than I found I could retain after a little experience of them. One of our enginemen complained of not being able to keep time; and being questioned about the cause, said they slipped more on the longitudinal than the cross sleepers. I doubted it, and he said, "You had better try it yourself." I took the earliest opportunity on a frosty morning soon afterwards, and found that on the level we were gradually losing time by slipping. I felt apprehensive that as soon as we came to the embankment between Hessle and Ferriby we should come to a stick-fast entirely, as the gradient is about 16 feet in a mile. As soon as we quitted the longitudinal road the engine ceased slipping; we put on full steam, and the engine went up like an arrow, and we made up for our lost time. We had then got on the cross sleepers. As soon as we got to the top of the elevation at Ferriby station, we again came on the longitudinal sleepers, and again commenced slipping in the same manner, and so continued for about seven miles; then we came on the cross sleepers again before ascending the bridge over the Market Weighton canal; and as soon as we got upon the cross sleepers, the slipping again ceased.

2213. Are there any observations you are disposed to

Mr. J. Gray.

make with reference to the question which is now occupying the attention of the Commission?

Uniformity.

I would observe, that it is very desirable to give one uniform Gauge, whatever it may be.

2214. Would it tend to much greater improvement in everything you are doing?

Yes.

2215. By the attention of manufacturers of engines being devoted to the improvement of engines of that Gauge alone, and not having their attention distracted?

Yes; it is very important there should be one Gauge.

2216. If you cannot be confined to one Gauge, you would mix them up as little as possible?

Certainly.

2217. Do you apprehend there would be much danger to the public, or much commercial difficulty or inconvenience, if on the Broad Gauge the Narrow Gauge were interposed, to run Narrow carriages in the same train, or separate trains, on the same line?

It would be a very complicated piece of business.

2218. Would it produce much complexity in the switches?

A great deal both in the switches and the crossings.

Mr. B. CUBITT, Locomotive Engineer to the Brighton, Croydon, and Dover Railway.

Mr. B. Cubitt. August 16, 1845.

Opinions on Gauge.

1297. I should say an equal power cannot be obtained by the Narrow Gauge as by the Broad Gauge, because the Narrow Gauge does not allow width enough to get a fire box large enough, and we are cramped for width in getting strength for the working parts of the engine.

1299. Do you imagine that in the Narrow Gauge you do not acquire by increased length, what you get by the width of the Broad Gauge line as far as regards evaporating surface and the fire box ?

I think not; I think it is impossible to make so effective a boiler for the Narrow Gauge, as can be made for the Broad Gauge.

1302. Will you state what parts require strength which you cannot attain with the width of 4 feet 8½.

It is not strength ; it is the length of the bearings that I most complain of. The length of the bearings for the crank axles if it is a crank axle engine, both for the bearings that carry the weight of the engine, and also the bearings or journals of the cranks.

1321. Will you state what increase you would make as a locomotive engine manufacturer to the Narrow Gauge to give you all the strength, all the speed, and the mechanical facilities for repair

Mr. J. Gray.

make with r… …ied: that
occupying t… …e adopted.

Uniformity.

I would obse… … one giving
uniform Gauge… …ased power,

2214. Would … …epair?
everythi… …efore, I think,
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Yes. …sider ample to
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2215. By … … any wider, with
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Yes … which it produces;
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2216. … damaged.

C… …aking of the axle?
… short bearings they
22… … dry; then they cut
…ced and made weaker.

… with the present con-
… Eastern Railway, you
… …ch increase of speed
… …erful engines?

Mr. William Cubitt.

August 18, 1845.

MR. WILLIAM CUBITT, Engineer of the Dover Railway.

Opinions on Gauge.

1503. Have you practically turned your attention to what increase of Gauge would give you the increased space most desirable for increased power?

If you go 6 or 8 inches over the present Narrow Gauge, you then get a Gauge that is wide enough perhaps for all practical purposes of machinery, of locomotive engines and carriages; and then, if you extend it beyond 6 feet, I should say you begin to get into difficulties of another kind, namely, cost and weight, and weakness of the machinery: your machinery must get heavier and stronger in proportion to the width of the Gauge.

1504. Then you consider that an increase of the width of the Gauge from 6 to 7 feet would be an evil rather than a benefit?

I think it would so turn out. I think a Gauge about 6 feet would be the best. There is no witchery in any particular dimension, but anything from $5\frac{1}{2}$ feet to $6\frac{1}{2}$ feet would be an excellent Gauge. If such a thing could be attainable, which I am afraid it could not, I should say 6 feet was the best Gauge that could be adopted. Everybody must say something, and I say 6 feet would be about the best; and taking everything to be good, 6 inches more or less would not matter.

1505. Are you aware whether it would be practicable to increase the Gauge to 6 feet upon the Narrow Gauge lines, taking into consideration the existing tunnels?

I have always considered the thing in this way: I have taken the size of certain loads and certain vehicles

which now pass upon the Narrow Gauges, and which are sufficiently large for any Gauge whatever practically, and those things all now pass with safety. I take the large post office carriages on the London and Birmingham Railway, which appear to be big enough for any carriages whatever upon any Gauge; and taking certain loads which they carry to be sufficiently large, so long as you keep the centre of the two roads the same distance apart, and so long as you keep the size of the loads restricted to what it has been at present upon the Narrow Gauge, the alteration of the Gauge would make no difference with regard to the numbers of bridges or anything.

1360. Do you think that an alteration of the Narrow Gauge to 4 feet would [illegible] necessity of widening the tunnels

I should [illegible] tunnels which they pass through [illegible] for the largest loads which [illegible] Gauge [illegible] so long as you keep the [illegible] at the same place, it can make [illegible]

[illegible] the width between the walls of [illegible] widening the bridges, the load being the same size as [illegible] large enough, would make it [illegible]

[illegible] the axle would be longer?

[illegible] difference with regard to the width [illegible] the width of the bridges. I have

always heard it said that you must alter all the tunnels if you widen the Gauge. I say no; if you do not alter the size of the largest loads you need not alter anything but the Gauge.

1509. Supposing they had carriages upon a wider Gauge, would they not wish to carry larger loads?

I think not. I think they are wide enough for any purpose In railway operations I would rather adopt the same width, making the vehicles of greater length, which would produce greater safety and greater convenience than by shortening them, so as to produce greater width and greater height.

1510. In fact, by using a wider Gauge in tunnels you would merely restrict the space between the walls and the side for the men who are employed in working in the tunnels?

It does not restrict the room for them as regards passing the trains. The wheels are always far inside the outside of the trains, and so they would be then, with the 6 feet Gauge, because the loads are 8 feet, and if you take a 7 feet Gauge it is just the same. All the difference would be that the two inner rails would be nearer to each other, and the two outer rails would be nearer to the walls. But the centre of gravity would be the same if the loads were no higher. What I think is wanted in railway operations is a good road, and the centre of gravity of all the moving bodies to be as low as possible.

1557. I think both Gauges require alteration.

1558. I think, as I alluded to yesterday, that a 6 feet Gauge would be superior to either of the present ones for all purposes. If altered at all, I think both should be altered. I think the Narrow Gauge is too narrow for many purposes connected with public convenience; and I think the Broad Gauge is broader than is necessary, and that there are some inconveniences from its

being admitted, I think both
eration be made.

opinion, as a practical engi-
the Narrow to the Broad
great degree, retarding, if not
for a time the traffic of those
are long or numerous tunnels,
and Birmingham?

might be altered by a piece at
a time, and still keep the trade

the reasons which induce you to
wider than 4 feet $8\frac{1}{2}$?

are these: first, we could get
engine gear, and by that means bring
of the whole engine lower. The
the engines is too high, in my opi-
would bring the engine as near to the
even if I passed the axles through it.
too high. I think a great deal of
accidents have arisen from a heavy
oscillating motion, and then falling or
This. The oscillation of the engine is

box large enough with the 4 feet $8\frac{1}{2}$

making them larger almost continu-
enty big enough for the fire-box with
ney.

meter of the boiler sufficient?

if you could have length enough;
Gauge you could get the boiler both
You do not want to make them
them long and low, and you get the

gear out of the way. I think outside cylinders will be a great improvement upon engines if they can be got to work without producing oscillation. Mr. William Cubitt.

1514. I suppose that the Great Western could carry a certain quantity of traffic perhaps a little cheaper than the Narrow Gauge. Economy of construction and of working.

1585. Looking at the probability of a great augmentation of railway communication in the country, and of almost all the large towns of importance being connected with other towns of similar consequence by railway, do you imagine that the Broad or the Narrow Gauge would be the best suited for such communications as regards goods traffic?

I do not know, because they are both capable of doing all the goods traffic in the kingdom. As I remarked yesterday, I think in all probability goods could be removed rather more economically in the large way upon the Broad Gauge.

1594. Do you happen to remember what was the whole cost of the South Eastern Railway?

I do not know at all; the cost of a railway is a very indefinite term.

1595. Independently of the plant?

Independently of the plant, I suppose it may have cost 24,000*l.* a mile; but that is almost like guessing, for I have quite forgotten the figures.

1596. Have you ever considered what increase of expense would have been due to an increase of the Gauge upon that railway?

I should say not more than 10 per cent. upon the permanent way, probably. The rails should be a little heavier, and an additional sleeper, and each of the

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sleepers about a foot longer. The earth-work altogether, and the works, are sufficient for the Wide Gauge, quite.

1597. Then are they not more than sufficient for the Narrow?

No; the South Eastern Railway is made with a wider base than any other line I know, and it affords much better drainage and much safer works, and it is comparatively easier to keep in repair. The base of the South Eastern was 36 feet at the formation line, which was the bottom of the ballast. There are instances in other railways, where it is as low as 27 feet (that is a great difference); and the tops of the embankments, also, on the same line, are 36 feet wide. Now that admits of great safety as well as excellent means of drainage.

1601. Large and powerful engines are more cheaply worked, in proportion, than small ones, for the work they do. With regard to manual attention and all that, it takes the same expense to work a small engine as a large one, and they can be more economical in coke with reference to the work they can do. The same quantity of repair will cover more work. I do not see why the lateral friction should be greater with one Gauge than the other, going the same speed.

1646. Is it an inconvenience on the Broad Gauge that large trucks are sometimes used to carry very small loads, especially from road stations?

That is an inconvenience upon any Gauge or railway to have little work to do for the waggons; but that does not obtain much, I should think.

1655. Do you think it likely that railway communication will be so far extended to small towns as to make it an object to adopt a system which admits of the use of small carriages both in passenger traffic and in goods traffic?

No; I do not think they will be made so economically

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as to supersede common roads upon that principle. A great many small branches on the side of a main line of railway make the railway expensive to work, and occasion the use of a greater number of carriages than are necessary, and they cause a great loss of time in consequence of producing so many stoppages. It is better to go a little out of the way to catch a number of towns than to go in a perfectly straight line, and to take branches right and left to the towns. Time will be saved and money will be saved by the adoption of a bending line of greater extent. A smaller length of railway will effect the object.

Break of Gauge

1491. Is it open to you to make the Paris and Lyons of any Gauge you please?

No, I think not; that would involve great difficulties from its communication with other lines. I believe that in practice, at present, all the lines in France are of the same Gauge. The North of France was begun upon that Gauge, and they are making the Amiens line the same.

1492. Do you imagine that a break of Gauge upon the lines with which you are connected upon the Continent would be attended with evil?

Any break of Gauge must be attended with evil, more or less.

1540. If a break is to take place, would it, in your opinion, be desirable that the break should take place at a place of great traffic, or at a place of moderate or little traffic?

I cannot answer that question off-hand, without going further into the whole question. Wherever the break of Gauge is to be, as far as passengers are concerned, that can be effected with the least trouble, because passengers themselves are locomotives, and what may be a step to one person only, is a step to each individual in a thousand. What creates the difficulty is the moving dead weight. The great question, I think, as to the transfer and

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Remedies.

change of Gauge is with respect to great quantities of heavy goods, such as coals and goods of that kind. That becomes a matter of ingenuity to devise the best, cheapest, and quickest mode of trans-shipment from the one Gauge to the other, whether it be by removing the goods from one carriage to another carriage, or by moving the body of one carriage on to another set of wheels by mechanical power. It becomes a question of cost, and nothing but cost, in my estimation; it is just a question of what it will cost per ton to do it quickly; that is the measure of the inconvenience. If only it has to be done upon a large scale, whether it is in a populous place or a place without population, it matters not at all.

1541. Have you seen the various modes proposed by Mr. Brunel for diminishing the evils of a change of Gauge?

Mr. Brunel's hydraulic apparatus.

I have seen very little of them. I saw his application of the hydraulic apparatus at Paddington. That is a principle which all mechanical people were aware of before, but the application of it in that case was very ingenious, and it acted very well. There are various modes of doing it, and that is a very good one, amongst others, if properly applied; and that is one that can be applied upon a considerable scale and to a considerable length of train.

1542. You might apply it to more than one carriage at the same time?

Yes, to a whole train at the same time.

1543. Would it be a matter of great expense to construct engines applicable to an entire train?

The expense is a matter of very little importance if you have great quantities to do, and you do it by this means at a small cost. For instance, in one case I have laid out 130,000*l.* to save about a halfpenny a ton upon the shipment of coals. Now that is a case in point. If they were to lay out half that money to save

a farthing a ton in the trans-shipping, the argument is the same; the cost has little to do with it. Mr. William Cubitt.

1544. Was that the Middlesborough Works?

Yes.

1545. Supposing that 25 waggons of coals all came up at the same time, in order they might be moved without any delay, it would require 25 machines such as those at Paddington?

Yes, I could put up apparatus that would move the whole of the 25 waggons in one minute, or in a couple of minutes.

1546. Requiring the employment of how many men?

Perhaps something not less than 50, nor more than 100. Then, if there was much of it to do, the cost of the machinery for doing it would be of little importance. It comes to the question of the cost per ton. If the trade is of such an amount that it may be done for a halfpenny a ton or a farthing a ton, that is the measure into which it resolves itself.

1547. It would be a trifle upon a long line, but a large item upon a short one?

Yes.

1548. Do you imagine that the mode of constructing carriages for goods, so as to be shifting, would diminish the strength of the material? Shifting bodies.

No; it is perfectly easy to make waggon frames and waggon bodies for a large trade that would go to any part of the country; the bodies must go quite through and return again; the frames would keep on their own lines, and the waggons would simply drop into them.

1549. Do you imagine that there would be any difficulty in constructing passenger carriages to move in the same way?

None at all; if there is enough of it to do to render it worth doing, there is no difficulty in doing it.

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1550. Is it not practised upon one of the French lines with the diligences?

I do not know, but it is a practicable thing. There are evils in having two Gauges, and as those evils probably must exist, they are to be met in the best way possible.

1551. You think the two Gauges may be combined in the way you have stated, without danger to the public safety?

As to safety, if the thing is well done, it may be safe enough.

1552. Where a thing is to be done, and upon a considerable scale of business as this must be (the loose box plan), it does not necessarily follow that there must be confusion any more than with regard to the present carriages of Railway Companies which travel to all parts of the kingdom. and of which there is a regular account kept, and a clearing-house for the whole of the companies; and as regards the great expense of the thing, expense must necessarily be incurred in consequence of there being two Gauges. There must be expense of some kind, either in altering the Gauges, or in adopting means to meet the difficulty of having two Gauges, and it is a question whether, under present circumstances, the expense of transfer will not be on the whole the least.

Clearing-house.

1555. It is impossible to blink the question of cost or of inconvenience anyhow, that must be incurred under any circumstances. I am one of those who think that restrictions of all kinds are to be avoided on trade and commerce and the transport of the country. The thing will much better find its own level for public convenience, I think, without restrictions than with them.

1560. Would there be any corresponding advantage in laying down on the Oxford and Rugby Railway, if made on the Broad Gauge, intermediate rails for the Narrow Gauge?

Mr. William Cubitt.

Intermediate Rails.

Yes; I think it would be found necessary to do that upon that railway, from what I have heard. I think I stated yesterday that it must probably come to that upon that line, having three rails on each line. That would be the simplest mode of doing it. It would require less points and crossings, and the switches would be as easily wrought as upon a single line.

1575. Are you of opinion that injury would be occasioned to the Staffordshire and Derbyshire coal if removed by hand from one waggon to another?

Damage by removing coal.

Yes; I think damage arises to any coal by that circumstance, and a great deal of money is expended in the north to prevent that. There are some coals so tender that they cannot be got to market at all on that account, which, if they would come in boxes the whole way from the mine, would come perfectly good to London.

Loose box

1576. Therefore you give the preference to removal from the one Gauge to another by a loose box and machinery rather than by transfer by hand?

Certainly; it would spoil the coals very much to shoot them out of one into another. They are very much damaged in the removals they now have from the mine through the ship to the fire.

1614. Several engineers have given it as their opinion that, at a shift of Gauges, it is better to transfer the loading in detail than in mass. Do you agree in that opinion?

Thinks minerals and heavy goods better shifted in bulk.

In some cases it might be necessary to do that, but very few. I think that all coals, minerals, and heavy goods generally are better shifted in bulk, that is to say in a body; that is my opinion. I think that, abstractedly considered, the greater quantity would be transferred best in the carriages; some articles might perhaps be necessary to be moved separately, but very few. The whole thing will be resolved into a question of cost. If a halfpenny a ton will cover everything on a large scale, as I believe it would, that defines the amount of the difficulty.

Mr. William Cubitt.

1615. Have you seen the transfer at Gloucester?

No.

1616. On the whole, you would prefer the loose-box system?

That is the most convenient, and I think it would be the least expensive. I have had a good deal of loose-box work, as I gave evidence on before the Gauge Committee, and there was no difficulty in it whatever, although we had to do it with cranes, yet the ease with which the earth-waggons were hoisted and dropped into the V's was very great; there was no difficulty really, and if those V's were on the points of springs for the pivots to drop into, they would ride perfectly safe; they would never jump out.

1617. Are you aware that this system has been tried in the keels at Newcastle, and at some points on the Manchester and Liverpool Railway, and at the Erewash, and that it has been abandoned?

No; but I am aware of many things that might be tried and abandoned, and yet that would not prove that they would not do well on a different scale, or for a different purpose. The abandonment of a thing in a case of that kind does not prove that it will not do in another situation, and for other purposes. In the case where I tried it, I should remark that we had to hoist the bodies into the boat and carry them seven or eight miles by water, and then take them out upon the railway and go on the work.

1618. Where was that?

It was in the shortening of the Oxford Canal, when so much work was done upon it about twenty years ago. I do not recollect the year.

1623 In fact, the amount of trade would regulate the number of machines?

Always; where a thing of that kind is necessary to be done, and where there is a will to do it, and mechanics

...re is always a way, and a tolerably — Mr. William Cubitt.

...u seen any of the plans proposed for ...heels upon axles?

...ld be done, but I do not think it would be — Telescope Axles.
...ient plan.

...uld it, in your opinion, be practicable and ...?

...ld be practicable, and could be made com-...ly safe, but the less moving and shifting of ...and parts of machinery the better.

...Especially where high velocities are concerned? ...ertainly.

1630. Are you aware that it has been proposed to carry Narrow-Gauge waggons upon Broad-Gauge trucks? — Narrow Waggons on broad Trucks.

I mentioned such a case myself in evidence on the subject. That is a possible plan.

1631. What is your opinion with respect to that plan?

I think it would be more costly and more difficult to manage, and as they would have a great deal more gross load to carry, they would not be so good as the loose-box system where there is a constant trade. For an uncertain trade, it might be a good thing to have the possibility of doing it.

1652. Supposing a continuous line from the north by Oxford, Didcott, Reading, or some other place on the Great Western and Basingstoke, or Winchfield to Southampton, what, in your opinion, would be the distribution of the traffic at different parts?

That I have not gone into at all. I never think much about the traffic cases; in fact, I know nothing about them at all.

Mr. William Cubitt.

Uniformity of Gauge.

1537. Again, to take the converse of a former question —if a proportion of the passengers and goods were destined for Rugby, would it not be an advantage to such travellers and the proprietors of such goods to have the break of Gauge at Rugby, and would not the amount of public convenience depend upon the proportion of travellers, &c., destined for Rugby?

Just so. The answer to all these questions is, that from Rugby to Oxford it would be exceedingly desirable to have both Gauges, as there must be a difference if the Gauges are not to be altered wholly. Then it would be like tapering off all the evils to a vanishing point, by having both Gauges between those two points. I think that would furnish an answer to the four or five cases which it resolves itself into, together with a proper understanding between the parties concerned in each railway. After all, it must come to that. They will quarrel for a long time, and then they will agree together to serve the public best for their own interest. Supposing the Croydon were to change their Gauge, it would, of course, be necessary for the Brighton and South Eastern proprietors to look out for another road to London.

Safety.

1494. All other things being equal, the levelest lines ought to be the fastest.

1497. With a perfect railway, I do not know any speed that could be dangerous to the public safety in a straight line.

1500. The great thing is want of perfection in the road, in my judgment, that has not kept pace with the improvement in the driving machine.

1502. I think the Narrow Gauge is wide enough for safety at almost any practicable speed, but it is not wide enough to get the most perfect machinery for speed.

1511. Is it not the fact that any great increase of the width of the Gauge would render it imperative to have a corresponding increase of the radius of the curves? Mr. William Cubitt. Curves.

No; if there is to be a great increase of the width of the Gauge, if you go from 4 feet 8½ inches to 7 feet, it would take a little more power, and there would be a little more torsion on the axles. But that would go on very well; it is easy to calculate the length that one wheel would have to slide while the other continued to roll; it would be an inch and a quarter perhaps in so many chains.

1512. Would not an increase of the Gauge admit of a corresponding increase of the height of the driving wheel?

No; I think the driving wheels may soon get too high for safety, except you have plenty of other wheels to keep on the road with. You may get the driving wheels of any height, but you must have six or eight wheels to the engines; or if there were ten, it would not signify; it would, perhaps, be all the better. Two fours and a pair of drivers would be a very safe carriage. Construction of Gauge.

1813. If you had an increase of evaporating power, it would, of course, give you increased speed?

Yes; we can come at increased speed in various ways; we must have means of getting an increased quantity of steam to meet that.

1514. Does it not follow that if the fire-box, the evaporating surface, or, in other words, the power of the engine, the height of the wheel, and the width of the Gauge, are duly proportioned with a view to attain the highest velocity with equal safety; that the superiority of velocity will be due to the Broad Gauge of the Great Western, rather than to any narrower Gauge?

I suppose that the Great Western could carry a certain quantity of traffic perhaps a little cheaper than the

Mr. William Cubitt.

Narrow Gauge. I think it is possible, but I do not think that increased safety arises so much from the Gauge as from the goodness of the permanent way. Nor do I think if we take the number of miles run on the Broad Gauge, and the number of miles run on the Narrow Gauge, that there are fewer accidents on the Broad Gauge than on the Narrow. That is merely matter of opinion. I have never seen any returns upon the subject; we have known engines run off the Broad Gauge, and we have known them run off the Narrow Gauge.

1515. You do not attribute it to the Gauge in either case, but to the state of the road?

To the state of the road, the rails not being in good order, the sleepers being imperfect, and the rails not joined perfectly. An accident will happen from a couple of rails parting at the junction, which will throw it off directly. Means may be taken to prevent this, by having them so that they could not rise one above the other.

1516. When you speak of the state of the road, are you alluding to favourable gradients?

No; as to gradients, that is a matter of less importance, if the road is in perfect order.

1520. With an equal state of the road, are you of opinion that a higher velocity is safer upon a broader Gauge?

I really hardly know how to answer that question properly; because common sense would say that it must be safer on the Broad Gauge.—I do not know whether it is so, because, except we increase the length of the parallelogram in proportion to the width of Gauge, I do not think the Broad Gauge is safer. Now, I do not think they have that additional length. If they were the same with a certain widening of the Gauge, we should get the parallelogram running broad ways forward instead of narrow ways forward. Then it gets a tendency to oscillation, and that is the greatest danger of all in railway speed.

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I think there is now too much play, generally speaking, between the flanges of the wheels and the roads. In high speed all things want to be made a little more perfect in all respects.

1577. It is understood to be contemplated to increase the power of the Great Western engines; would not that add to their weight also?

As things are now established, I think it would.

Speed.

1578. Are you of opinion that such an increase of weight with an increase of speed would be injudicious in the present state of the roads?

Yes.

1579. Looking at the possibility of a great rivalry between the Broad Gauge and the Narrow Gauge Companies as to speed, do you think there is a maximum of speed to which it would be desirable to limit those Companies for the sake of public safety?

Opposed to limiting speed.

No, because I do not think you get any greater safety by limiting speed. I do not think we have heard of more accidents occurring in consequence of speed at all at present.

1580. But the question contemplates the possibility, nay, almost the certainty, of a great rivalry now in speed, which will assuredly lead to a great increase of speed; would it, therefore, not be desirable to guard the public against that danger by limiting the speed?

I have still to learn how danger is with regard to speed after you get more than 20 miles an hour. It can only have regard to the greater chances of accident with additional speed; nothing else. Damage will ensue if you go only 20 miles or even 15 miles an hour, and a breakdown occurs; with such a mass in motion, at the rate of

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20 miles an hour, it will be quite enough to throw the whole train of carriages and goods in a heap, one upon another.

1581. The question assumes that the state of the roads is hardly such as even to justify the present speed; and you appear to be of opinion that with certain weights a greater speed is not safe in the present state of the road?

I think the best limit of all is a very stringent punishment when an accident occurs, and not to make a law to limit the speed, because you do not know where to limit it. The Railway Companies, the parties understanding the matter, know best; they know very well where they may drive fast and where they must drive slow; but if you make a general law to limit speed, I think more harm than good will be done.

1582. Do you mean that the consequences of an accident when going 20 miles an hour would be as bad as the consequences of an accident when going 50 miles an hour?

That is pretty much the thing, though it is not exactly so.

1583. Is it not more likely that an accident will happen when going 50 miles an hour than when going 20?

I do not exactly know whether it is. There are some cases in which speed will get over a difficulty that a slower motion might meet with.

1584. Would not an increased dimension of the balk and an increased weight and strength of the rail remove in some degree the objection to the additional weight and speed of the engine?

As I observed yesterday, the first step to safety is a most excellent road, the best road that can be made, and

then I think you need not limit the speed; and till that is the case, limiting the speed will not cure the evil.

1593. You are not of opinion that any accidents are attributable either to the Broad or the Narrow Gauge?

I think not. I do not think the Gauge has ever been the cause of an accident.

1601. Is it not the fact that the most powerful engine is the cheapest to work with a proportionate load?

Yes; large and powerful engines are more cheaply worked in proportion than small ones for the work that they do.

1602. Do you mean cheaper with regard to the consumption of coke?

Cheaper altogether. With regard to manual attention, and all that, it takes the same expense to work a small engine as it does a large one, and they can be more economical in coke with reference to the work they can do.

1603. Do they require less repair?

The same quantity of repair will cover more work. I think there is a little economy in each of the items.

1604. Is the lateral friction greater with one Gauge than with the other?

No, I do not see why it should be, going the same speed.

1605. Except from the circumstance of the shortness of the carriages in the one case as compared with the other?

Yes, when oscillation comes in there is more wear and tear. I think all the very heavy engines ought to go upon more wheels.

[redacted] It is understood that the engines now being manufactured by Mr. Robert Stephenson have a length [redacted] between the front and hind axles, with a [redacted] to admit of an increased length of boiler; are [redacted] aware of any practical inconvenience in such an [redacted], or do you think it will tend to give the engines greater steadiness on the rails?

[redacted] ems to give the engines greater steadiness on the [redacted] no doubt. The only inconvenience is in the sharp [redacted]. My feeling is, that perhaps the best possible [redacted] would be obtained by what the Americans call a [redacted] carriage, before and behind, with four wheels each, [redacted] large driving wheels without flanges between.

[redacted] With respect to mineral traffic, have you any experience of mineral districts to enable you to judge whether the proprietors of coals and other minerals will prefer the Narrow or the Broad Gauge for their traffic?

[redacted] have not had experience enough to answer that question decidedly, but I think they would prefer the Narrow Gauge to suit their purposes.

[redacted]. In the carriage of horses and other animals, has the Broad Gauge any advantage that you are aware of over the Narrow, as far as regards convenience?

[redacted]. I do not think the horse-boxes are more convenient on the one Gauge than the other. The Broad Gauge might take horse-boxes of four horses, while the Narrow Gauge might take a horse-box of three; but the [redacted] would be heavier and more costly. There is [redacted] an evil to countervail the advantage when we [redacted] in either case.

[redacted]. Do you conceive that the Narrow Gauge has any

advantage over the Broad, for the accommodation of passengers? Mr. William Cubitt.

Nothing real, perhaps; but it is generally deemed more convenient for riding. The four-inside carriage has windows on both sides, and the passenger-carriages on the Narrow Gauge are so far more comfortable. In fact, in the enjoyment of two windows, there is a comfort in seeing the country on both sides. Passenger Convenience

1592. The Great Western carriages are, however, considered more commodious?

They will hold more people, and you can stand upright in them; and so you can in some of the Narrow Gauge carriages now. They can put a greater number of passengers on to the same number of wheels on the Broad Gauge; and so far it is commodious in packing them; but whether it is more convenient or comfortable to the passengers I rather doubt.

Col. G. Landmann.

August 15, 1845.

COLONEL GEORGE LANDMANN, late of the Royal Engineers—Engineer of the London and Greenwich Railway.

Opinion of Gauge.

954. During the great discussion of the question of Gauge, did you at all consider the point with reference to the Broad and Narrow Gauge when the Great Western Railway was being formed?

Considered Wide Gauge wider than necessary—an improvement, but hopeless to introduce it generally.

I thought that it was an improvement, but from the progress which railways had then made, I looked upon it as a hopeless thing to introduce it as the general Gauge. I think it is wider than is necessary; I think a narrower Gauge might be used with perfect security.

955. In constructing the continental railways which you have in contemplation, the field being perfectly open to you to adopt what Gauge you think fit, are you disposed to make any increase in the 4 feet 8½ Gauge?

Intends to increase width of continental railways designed by him.

Certainly, if left to my decision.

956. What is your principal object in desiring an increase of Gauge?

I think it gives greater safety in keeping the engine on the road. There is an inconvenience in curves, but I think, by widening the Gauge, you lower the centre of gravity, which is necessarily a great advantage.

957. One of the great objections to the Narrow Gauge in the early period of railway construction in this

Col. G. Landmann.

country was the space, being considered too confined for the construction of locomotive engines to give you the power necessary. More recently, another system of construction has been adopted, by which it is said to be found that the space is ample. Would that circumstance alter your intentions with regard to the continental railways?

Thinks wider the base safer carriage from overturning.

No; my opinion is formed entirely regardless of the construction of the engine itself. I think, the wider the base upon which the carriage runs, the more secure it is against overturning, although I believe it is not common for the carriage to overturn under any circumstances.

958. Did you ever know a case of an engine being upset upon any line?

Never heard of carriage upsetting on the line.

I cannot say that I have any very clear knowledge of the fact. I have nothing but the newspaper accounts of matters of that kind to govern me. I think I have heard of an engine being upset. I believe an engine was upset upon the Northern and Eastern.

959. Where it ran off the line?

Yes.

960. Is there any tendency to upset whilst it is on the line?

No, I think not.

Maj.-General C. W. Pasley.

Dec. 18, 1845.

Major-General Charles William Pasley, C.B., Inspector-General of Railways.

Uniformity.

6526. In 1843 it appeared to me too late to attempt to introduce uniformity of Gauge in Great Britain, where at that time four several Gauges prevailed, viz., the Great Western and its extensions and branches of seven feet, whilst the Eastern Counties to Colchester, and the Northern and Eastern Railway to Bishops Stortford, were on a Gauge of 5 feet, recommended by Mr. Braithwaite; but the London and Birmingham, and all the other passenger railways in England, were on the Narrow Gauge of 4 feet 8½ inches. This last Gauge also applied to the Edinburgh and Glasgow and to the Glasgow and Ayr, and other railways proceeding from Glasgow; whilst the 5 feet 6 inches Gauge had been adopted on the Dundee and Arbroath and on the Arbroath and Forfar railways. I remained of the same opinion until lately, when the appointment of this Commission by her Majesty induced me to reflect more upon the subject, and the establishment of an uniform Gauge for all Great Britain appears to me so very important that the advantages of it will far outweigh the temporary inconvenience to the travelling public and the expense of establishing it. I have further to observe, as a proof of the facility with which the Gauge of a railway may be altered, that on the Norfolk Railway being made to connect with the Northern and Eastern Railway, the existing Gauge, not only of the latter, but also of the Eastern Counties Railway, which two Companies had become amalgamated, was altered from 5 feet to 4 feet 8½ inches, under the directions of Mr. Robert Stephenson. This was done in six weeks in a very able and effective manner, without occasioning any accident, and without materially impeding the traffic on those railways, which continued as usual, one line only

having been altered at a time, and temporary ridings made where the up and down trains passed each other.

6527. You are of opinion that the break of Gauge is a great evil in the country?

The greatest possible disadvantage.

6528. And you think that the best way of remedying that is by a total reform of the existing railways, so as to produce one entire harmony of Gauge?

I do. I may observe that, in all probability, the mileage of railways in Great Britain will be doubled, or may be trebled, in the course of a certain number of years. It certainly will be doubled, and therefore that is another reason for not adhering to either of the present existing Gauges, if a better can be adopted.

6529. You think the time has now arrived for taking some decided step one way or another?

I think it has; but it would have been better to have taken it earlier.

Mr. Richard Roberts.

November 4, 1845.

Mr. RICHARD ROBERTS, late of the firm of Sharp, Roberts and Co., Manufacturers of Locomotives.

5353. What deficiency of space have you got in the Narrow Gauge?

Perhaps you will allow me to observe, that some years ago I wrote a public letter upon the subject. That letter appeared in the *Railway Times* of, I think, September 8th, 1838. I wrote it in reference to the Gauge laid down by the Irish Railway Commission. I stated that I thought they were not right in their Gauge, and that a Gauge of from 5 feet to 5 feet 4 inches seemed to me all that would be required.

Recommends a Gauge of 5 ft. to 5 ft. 4 in.

Gauge of 5 ft. 6 in. unnecessary.

5362. You think that a Gauge of 5 feet 6 inches is not called for?

No.

5363. We have had the evidence of Mr. Brunel, who is the advocate of the Broad Gauge; he says that he thinks that the Broad Gauge is hardly broad enough, and he would prefer having still larger engines and greater power?

Does not comprehend Mr. Brunel's desire to extend 7 ft. Gauge.

I do not comprehend Mr. Brunel.

5364. Have you constructed any of the Broad Gauge engines?

Yes; we have constructed from 18 to 20 engines for the Great Western.

5365. Do you think that all the advantages have been taken in the construction of engines for the Great Western of the width of the Gauge?

I cannot tell what to understand by "all the advantages." I do not know what they ran for.

Mr. Richard Roberts.

5366. One of the objects of the Broad Gauge, we are told, is to give increased power, and to attain increased speed?

They have not taken advantage of the Gauge to obtain greater power than on ordinary lines.

Curves.

5408. Are you inclined to think that the Broad Gauge engines suffer more injury from passing round curves of the same radius than the Narrow Gauge engines do?

Difficult to broad carriage.

Yes, and if the axles were put at a distance asunder, which should bear the same proportion to the width of the Gauge in both cases, those of the Broad Gauge would suffer considerably more in curves.

5418. Do you see any objection to your having loose wheels for the passenger carriages or waggons?

Certainly.

Objects to loose wheels as dangerous.

5419. What is the peculiar objection to that?

A liability to run off, and then to run wild when they are off.

5420. You object to loose wheels generally?

Yes; most decidedly.

5421. Was the construction of wheels and axles in one an original construction, or was it accidentally they were so constructed?

No, I think they were loose originally; the axles were mere pins on tram-road.

Mr. Charles Vignoles.

Aug. 12, 1845.

History of Gauge.

MR. CHARLES VIGNOLES, Engineer of the Saint Helen's and Runcorn Gap, the North Union and Midland Counties Railways.

Was Engineer of St. Helen's and Runcorn Gap—Sheffield and Manchester Gauge of 4 feet 8½ in. in consequence of connection with Liverpool, and Manchester, and Midlands.

759. I was the engineer of the St. Helen's and Runcorn Gap Railway. The Gauge is 4 feet 8½ inches, the same as the Liverpool and Manchester Railway, in consequence of being connected with it. It is a down traffic. The Midland Counties Railway was begun about ten years ago, and it took about three years to execute. I think it has been opened six years. That has also a Gauge of 4 feet 8½ inches, in consequence of its branching from off the London and Birmingham Railway, and working in connection with it. The *Sheffield and Manchester Railway* was commenced by me, although not completely executed. I ceased to be the engineer soon after the works were commenced; but it was laid out, the working drawings made, and the contracts prepared before I left, and the Gauge was settled at 4 feet 8½ inches, in consequence of the connection that this line necessarily would have with the Liverpool and Manchester Railway on the one hand, and with the Midland railways on the other.

765. Are the stations at Manchester of the Liverpool and Manchester and the Manchester and Sheffield joint stations?

No, that connection has not yet been made; but a connection has been made with the Manchester and Birmingham Railway, with which it has a joint station in Manchester; and the two Companies are uniting in extending their line through Manchester by what is called the South Line, an Act for which was obtained this year;

Mr. Charles Vignoles.

so that there will be a complete communication from east to west. The Sheffield and Manchester line is also about to be connected with the Sheffield and Rotherham Railway at the Sheffield end; and a variety of other extensions are proposed from it, necessarily, of course, requiring the same Gauge. I laid out the *Eastern Counties Railway* originally in conjunction with Mr. Braithwaite; but that gentleman executed it. A question as to the Gauge on that line arose. I was then very desirous of making the Gauge for railways wide, and a great deal of discussion arose upon it, and Mr. Braithwaite's view of having a 5 feet Gauge was adopted. I should have preferred to have had a still wider one, a 6 feet Gauge; but after the Act of Parliament was obtained I took very little part in the affairs of the Eastern Counties Railway. I only gave my opinion from time to time. The *Dublin and Kingstown Railway*, which I executed in Ireland, I intended to have been a 6 feet Gauge; but the Directors over-ruled my opinion upon the plea, that so short a line might, if it was hereafter found necessary, have its Gauge altered without inconvenience; but as they had to obtain all their first carriages and engines of every description from England, where 4 feet 8½ inches was the prevailing Gauge, they thought, as matter of economy in getting their materials, they had better adopt the same Gauge; and as it was the first railway that was introduced into Ireland, the Directors were very unwilling to depart from what was then considered the established principle. It was commenced about fourteen years ago, and has been opened nearly eleven years. Those are the principal lines which I have executed in England. Besides those, I have been consulted in the laying out of many of the principal railway lines, and also upon the Gauges of a great number of them. For instance, the *Edinburgh and Glasgow Railway* was laid out by me, though not executed by me. There the question of Gauge did not arise during the time that I was more immediately directing it; but I was consulted at the time, and the general feeling of all the Directors was, that as it was likely to connect ultimately with the lines coming from the south, which were all upon the 4 feet 8½

A variety of extensions proposed on same Gauge.

Wished to have Dublin and Kingston on 6 ft. Gauge, but over-ruled.

Mr. Charles Vignoles.

inch principle, that Gauge should be adopted. Some of the Scotch lines that have already been executed are upon rather a Narrow Gauge. I think one coal line was upon a wider one, 5 feet 6 inches, the Forfar Railway. But the general feeling was very strong at that time, that a connection with the south lines should be kept in view. I should observe that most of those lines that I have mentioned, at least the early ones, were previous to the introduction of the Broad Gauge by Mr. Brunel, previous to his having determined upon it, and previous to that long discussion which took place when the question as to what the Gauge should be arose. On the Continent, in laying out the *railways in Brunswick*, the same feeling existed in the minds of the Governments and the Government engineers, that while the first engines and the first carriages of every description had to be obtained from England, they were unwilling on the Continent to enter into any deviation from what happened to be the fixed rule in England. The first railway in Brunswick was about 30 miles to the foot of the Hartz Mountains; and it was determined, after a good deal of discussion, that the English Gauge should be adopted, 4 feet 8½ inches. The latest large operation of mine on the Continent was the *Würtemberg railways*, which are now being executed. There the question of Gauge was very greatly discussed indeed, and, in fact, is not yet settled. The Würtemberg railways are intended to unite the Rhine and the Danube: that is to say, the railways in Baden, which run parallel to the Rhine, and the railways in Bavaria, which run from the Danube. The Gauge of the Baden railways I think is 5 feet, or 5 feet 6 inches, and the Gauge of the Bavarian railways is the English Gauge of 4 feet 8½ inches. A very careful investigation was made by me upon the subject, and after a long consideration of the subject I wrote rather an elaborate report, and taking all the circumstances into consideration, I recommended that 4 feet 8½ inches should be adopted. They had to choose between the two Gauges, and as all the railways in connexion with Bavaria, leading as far north as Hamburg, and all the Saxon and Austrian railways are 4 feet 8½ inches, and as a great deal of transit

Narrow Gauge adopted on Edinburgh and Glasgow, for uniformity with probable English lines.

In Brunswick Narrow Gauge adopted.

Recommended Narrow Gauge for Würtemburgh lines to preserve uniformity with Saxon and Austrian lines.

Mr. Charles Vignoles.

trade was coming from those countries, I considered that the larger amount of traffic would be from the railways having 4 feet 8½ inch Gauge, and that the length of rail that they would be connected with on the Baden side, next the Rhine, would be short in comparison; and I thought that Baden would ultimately be obliged to change the Gauge, and bring it to the Gauge of the others on the Continent. However, Baden has persisted in not changing her Gauge, and Bavaria persists in not changing hers, and it is a question at what point the transit of merchandise from the one Gauge to the other shall take place, whether it shall take place upon the eastern or western frontiers of Würtemberg. The railways are not sufficiently advanced, and the question still remains open; but I think the probability is, that, taking all circumstances into consideration, they will ultimately adopt the 4 feet 8½ inch Gauge throughout Würtemberg.

Baden persists in 5 ft. or 5 ft. 6 in. Gauge.

766. What is the relative proportion between the Baden and the Bavarian railways in length?

At present the eastern railways are the longest, if you take the Bavarian railways in connexion with the railways in Saxony and the railways in Austria, which will extend to Augsburg, Munich, and Vienna, on the one side, and to Munich, Dresden, Leipsic, Berlin, and Hamburg, on the other. Making a large preponderance in favour of the Narrow Gauge.

On lines preparing for, or passed by Parliament will introduce Narrow Gauge, because connected with Bolton and Manchester—same width 100 miles of railway running into Westmoreland.

On a great number of lines preparing, and in several lines passed this session of Parliament, (for instance, the railway from Blackburn to Bolton, on which I shall have to introduce gradients of 1 in 70,) I must introduce the Narrow Gauge, because it is connected with the Bolton and Manchester Railway. Then I am preparing nearly 100 miles of railway in connexion with the Blackburn line, running into Westmoreland and beyond; and then again, in England, I am preparing a vast number of railways in the interior of the country, in Nottinghamshire and Lincolnshire, and Leicestershire, all of which must be upon the Narrow Gauge.

Although my impression is in favour of a broader

Mr. Charles Vignoles.

Gauge than 4 feet 8½ inches, still, where so many lines have necessarily to be connected together, the circumstances I have explained have hitherto prevailed. Where there is a new country, such as Ireland, which has hitherto got but a short distance of railways, the case is different, and the Gauge can be increased.

769. After the experience you have had, it appears from what you have said, that you are still of opinion that a 6 feet Gauge is the best?

Intermediate Gauge.

I am, but that is a very different question from whether an alteration should take place to that Gauge; but I still prefer the 6 feet Gauge.

770. Will you be so good as to assign your reasons?

Prefers the 6 ft. Gauge.

Although the improvements in machinery and the improvements in the construction of locomotives have enabled a great deal of the first difficulties to be overcome, namely, from the want of room; still, looking at the improvements that are taking place, I think we do not get the full benefit of them, from our being still restricted within the Gauge of 4 feet 8½ inches, that is, that having a 6 feet Gauge to work upon, and applying the same degree of improvement, we should have a much better machine. Then again I think, with respect to the 6 feet Gauge, you might be able to have the advantage of having a larger body of carriage within the axle, or a still larger body by letting the carriage hang over the axle. Each of those are of themselves of considerable importance; but I think also that there is certainly theoretically more stability in the wide Gauge than in the narrow one. I do not wish to push that too far, but there is a certain amount of advantage in it which, I think, weighs very greatly in leading me to prefer it, *but would not weigh sufficiently to induce me to change*. I am quite free to admit that vast improvement has taken place since the Narrow Gauge was introduced, and a great number of those objections, which existed very strongly in the first instance, from want of room for the machinery, have been overcome

Would not change.

by the ingenuity and perseverance of our leading engineers. Mr. Charles Vignoles.

771. Will you have the goodness to furnish the Commissioners with your reasons at large for having preferred the 6 feet Gauge at an early period. Do those reasons lead you to wish a still wider Gauge than 6 feet?

No, I do not mean within an inch or two; but in fixing upon 6 feet, I was led to it from a variety of calculations, that I should be able to get certain additional space for the engine and machinery and space for the carriages. It is a long time ago since I entered into this discussion, and therefore I must refer to my notes; but my general impressions led me to the conviction that we should have a larger Gauge than 4 feet 8½ inches, and I thought that in fixing 6 feet, I was going as wide as would be consistent, with a regard to the extra expense that would necessarily be incurred by it. Reasons for advocating 6 feet Gauge.

772. In the statement which you propose to deliver in, will you be so good as to include an account of the extra expense?

That depends upon circumstances. The impression I had in my mind was, that the expense of the carriages would be very nearly in proportion to the squares of the Gauges.

773. But you would have more accommodation with the Broad Gauge?

Of course more accommodation; but I am speaking of the cost of the carriage frame: I think I made it out that it would increase as the squares of the Gauges; but of course you would have a certain additional amount of accommodation. One great advantage of a large carriage is, which applies particularly to this Broad Gauge, that with properly constructed carriages you get less gross weight in proportion to the net weight. I do not know

Mr. Charles Vignoles.

whether that has been realized in practice, but I think it ought to be so, and that it might be so.

Economy of Working.

778. With respect to the economy of working of the Great Western, I can only judge of that from the public reports; and the last time I had occasion to investigate them, I found that the expense of working per mile per train, on the Great Western and the London and Birmingham, was as near as possible the same.

779. The trains being equal in load?

I assumed that to be the case; I had no reason of knowing it.

Speed.

Attributes speed of Great Western to gradients rather than Gauge.

778. As regards increase of speed, I do not think that upon that alone the Great Western have an advantage. I think the trains travel very fast upon the Great Western, but I think much more is due to the gradients, which are very flat generally upon that line, than to the Gauge.

Safety.

780. With respect to safety, as far as it is connected with steadiness, I am quite satisfied that, at very high velocities, the trains travel more steadily on the Great Western than on the London and Birmingham.

788. Are you of opinion that the longitudinal sleeper gives a facility of travelling at high velocities, more than the transverse sleeper?

I never considered it in that point of view; but I should think not. I should observe, with respect to the longitudinal sleeper, that my mind has of late been rather shaken.

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782. If you had a length of line of 10 miles nearly level on the London and Birmingham, and 10 miles nearly level on the Great Western, do you think

there would be the same advantage on the Great Western? Mr. Charles Vignoles.

I do. I am quite satisfied that at the high rates of velocity it is steadier. Of course, large allowances must be made for the movement over those places where the road is out of order, and for such places where it is in good order; but, taking all that into consideration, I think the Broad Gauge has the advantage of steadiness. I do not mean to say that that alone would justify the 7 feet Gauge; but, answering the question in the abstract, I am quite satisfied there is greater steadiness of motion at high velocities. I have travelled very often down the London and Birmingham, by the express trains, and the oscillating motion and the want of steadiness are decidedly greater than on the Great Western. Opinion on Gauge.

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801. With respect to the question of altering the lines for the Gauges, there would be inconvenience for the time, but it could be done. Uniformity.

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809. With less than 30 feet breadth of road, would there be room for a man to be in safety?

There would not; it is 6 feet between the rail, and therefore half 6 feet to the other side; therefore it is twice six and twice seven, and then as much more as you can let a man squeeze up against the wall; but it would be better that there should be recesses built in the tunnels. That with less than 30 feet breadth of road there would not be room for a man in safety.

810. But the workman might not be near a recess when the trains were coming?

Of course, he might squeeze up tight; but for tools and other things a recess in the tunnel is very convenient.

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811. Have you at all considered upon the question of the break of Gauge, the inconvenience it is likely to entail on the traffic? Break of Gauge.

Yes, I have considered that a great deal, but I cannot

Mr. Charles Vignoles.

conceive any great inconvenience. There would be no inconvenience to the public certainly, because where the Gauges met the Companies would be interested in accommodating the public as much as possible.

812. Have you contemplated the meeting of Gauges at Rugby?

Yes; I think Rugby the best place for the meeting.

813. Rather than Oxford?

Certainly.

814. Will you state why you think a place of large traffic is more convenient than a place of small traffic?

Thinks break should occur where most traffic meets.

Because the preparations there may be made for it on a greater scale, more contiguously, more certainly, and with less delay.

815. You mean less delay where there is much work to do than where there is little to do?

No. The object is to get a large force on one train that wants to accomplish it. The trains do not come at all times, but they come up in succession as regards the extent of the traffic. Besides, as regards Rugby, and as regards Oxford, nearly the same amount of traffic would come to Oxford that comes to Rugby; otherwise, why do you go to Rugby? There is no intermediate town of consequence until you come to Oxford. Of whatever comes off the Midland Counties and the London and Birmingham Railway at Rugby, nearly the whole will go to Oxford; there is very little to stop intermediately.

816. What do you suppose to be the nature of the goods that would be taken on at Rugby towards Oxford?

I should think chiefly coal.

817. Do you not think a great deal of that coal would be dropped between Rugby and Oxford? Mr. Charles Vignoles.

Not much.

818. Is it not for the supply of that country?

It is a country very thinly peopled; Banbury is the only town I think of any note

819. If you were a coal-owner, and filled a train with coal north of Rugby, should you not rather be desirous that bulk should not be broken, or any transfer take place, till it arrived at its destination at Oxford? Loose Boxes.

I think as regards bulk being broken, that is quite out of the question; the bulk must not be broken; the coal must not be disturbed; but of course the boxes will have to be lifted, and if the expense of that did not fall on the coal-owner I think it would be a matter of indifference. Opposed to breaking bulk.

820. Must it not fall on the public?

Supposing there be a competition for coal or traffic, it would fall on the Railway Company; but the expense of it, carried on systematically and properly, is so small that it may be quite put on one side.

821. How would you propose to make the transfer; do you propose a system of boxes?

Yes; or a Narrow Gauge waggon run on to the Broad Gauge truck, or in any other way. Experience after a little trial would soon determine that. Suggests loose boxes and waggons run on trucks.

822. What would be added to the gross weight by running the Narrow Gauge waggon on the Broad Gauge truck?

It would add to the gross weight the weight of the Broad Gauge truck.

Mr. Charles Vignoles.

823. Which would be how much?

One Broad Gauge truck would hold two narrow waggons.

Perhaps 30 cwt., or from that to two tons; it would depend on the size. One Broad Gauge truck* might be very conveniently arranged to hold two Narrow Gauge waggons.

824. (To Mr. *M'Connell.*) What is the weight of a Broad Gauge platform truck?

About 3 tons 5 cwt.

Thinks Companies cannot charge for dead weight.

825. (To Mr. *Vignoles.*) That would add considerably to the gross weight?

Yes; that is for the consideration of the Railway Company who carry it; they cannot charge the public anything for that.

* See Mr. Stephenson's evidence on Break of Gauge, p. 104.

Mr. I. K. Brunel.

Oct. 25, 1845.

ISAMBARD KINGDOM BRUNEL, Engineer of the Great Western Railway, and Inventor of the 7 feet or Broad Gauge.

History of Gauge.

3918. Had you, before you took the management of the Great Western Railway, any employment in railway matters?

No.

3931. Having seen the working of other railways, and of the Great Western since its entire opening, are you inclined to think it was an injudicious arrangement to alter the Gauge to 7 feet, or that a less difference would have been better?

To answer that, as I will endeavour to do, with candour, I incur the risk, I am afraid, of being accused of adopting wild notions; I should rather it be *above* than under 7 feet now if I had to reconstruct the lines.

3978. You were Engineer of the Taff Vale? Yes.—Did you decide the Gauge of that line? Yes.—What induced you to depart from your more general system in that particular instance?

Taff Vale laid out on Narrow Gauge under the *mistaken* idea that Broad Gauge was unsuited for sharp curves.

One of the reasons was one which would not influence me now. At that time I assumed that the effect of curves was such that the radius of the curve might be measured in units of the Gauge, then I expected to have to lay out that line with a succession of curves of

Mr. I. K. Brunel.

small radius, which is the case as the line is laid out; and I assumed that the Narrow Gauge was better than the Wide Gauge as regards curves.

3983. Is it optional with you to fix the Gauge of lines projected in Ireland of which you are the Engineer?

Objects to Intermediate Gauge.

I have understood that it is a question which has been pretty nearly decided by higher authorities, and that it is to be 5 feet 3 inches. I do not myself see much use in the four or five additional inches.

3986. You are the Engineer of some Foreign Railways?

Yes; the railway making from Genoa to Turin, under the Sardinian Government.

3990 Is the question of Gauge an open question there?

Yes; except as far as I may have decided it.

Has recommended narrow Gauge for Sardinian Railways.

3991 How is it decided for that particular line?

I recommended 4 feet 8½ inches.

3992. Is there any reason which induced you to give that recommendation?

The reason that led me to adopt it was, that I did not think that either the quantities or the speeds likely to be demanded for many years to come in that country, required the same principle to be carried out, that I thought was required here, and I thought it very important that they should secure the good will of certain other interests which would lead into and out of this railway; as a question of policy as much as of engineering I advised them to adopt that Gauge; I thought it was wise to conciliate the interests of the Milan and Padua Railway, and others which are likely to be con-

To secure uniformity with projected adjoining lines.

nected with us. The Milan and Venice is being constructed, and the part between Padua and Venice is open. We hope to join at Milan, but there is a short space of Austrian territory between Milan and the Sardinian frontier, and I thought it likely that the connection between the two railways would be facilitated by our offering to adopt the same Gauge. If there was no reason whatever for fixing the Gauge at the smaller width, connected with other railways or other interest, I think that, in all probability, I should have adopted a wider Gauge. Mr. I. K. Brunel.

3997. In the railway which you contemplate making to Portdynllaen from Oxford, do you contemplate using the Broad Gauge?

Yes.

4003. Do you think the traffic of that place would equal the traffic of the Italian line?

Yes, upon a considerable portion of the Italian line there will be a good deal of goods traffic. Genoa is a large importing and exporting place, with a very populous district round it. Thinks the Welsh traffic would equal that on the Italian line.

4005. Looking at the whole question, are you of opinion that you have in the main realized the objects you had in view in the adoption of the wider Gauge?

Yes, I think so.

4029. It has been represented that serious impediments to the internal traffic of the country are likely to arise from the break of Gauge that will occur in Break of Gauge.

Mr. I. K. Brunel.

railway communications from want of uniformity; —will you be so good as to state whether you think that any serious inconveniences are likely to arise from the break of Gauge?

Break of Gauge will occasion some inconvenience.

I think some inconvenience will occur. The amount of it will depend very much upon the particular line of country upon which the change takes place, and upon the interests of the parties on either side either to increase or diminish the amount of that inconvenience. I think that if the change took place across the country, so as to separate London from the north, that would be a case of the greatest interruption, and would of course produce a good deal of inconvenience. If that change took place as between one portion of England and the other, leaving London open to both, the inconvenience would be small; and that, if it is the interest of the parties on both sides of the neutral country (if there is one between the two) to effect a transit through it, I believe that it will be very small indeed. It will be diminished even with the extension of the railway system; because if such a network of railways as has been referred to over England is made, I think it will be impossible that the passenger carriages can be running in all directions over that network without changing, and I do not think it would be for the advantage of the public that they should. I think the spirit of emulation and competition kept up between different great railway interests, both as regards the comfort and the construction of the carriages, and the times and mode of travelling, will do much more good to the public than that uniformity of system which has been so much talked of the last two or three years; and I believe that, as the number of railways extend over the country, it will become more and more impossible to send individual passengers by separate carriages to the exact place of their destination, and that a change of carriages must, in a great many cases, take place; and if that change takes place over a general line of country, it will gradually influence the mode of travelling throughout all the directions in which lines may be

Thinks the emulation of two systems better than uniformity.

Mr. I. K. Brunel.

carried, and will then, I think, amount to a very trifling inconvenience. As regards goods, it is of course a mere question of money; and if there is a considerable stream of goods on one line, and it is the interest of two parties meeting at a certain point to interchange those goods, I believe the inconvenience and expense will be so trifling that it is hardly worth consideration, if there are other important considerations in the question of the change of Gauge.

The transfer of goods a mere question of money.

4030. You are of opinion that it would be a great public inconvenience to have a change of Gauge at Rugby for passengers going northwards from London, or coming southwards to London?

Yes; I think it would be exceedingly to be desired that all the mass of passengers going from London northwards, should be able to go on without changing at Rugby, where there can be, in all probability, no great reason for their changing, if they are going northwards upon the same line.

Thinks there should be no change for northern passengers at Rugby.

4031. But you do not think that the same amount of inconvenience would be felt by the public in the change of Gauge at Rugby by persons coming from the North going to Oxford?

No; or for persons coming from Oxford and going to the North; for this reason, that the persons going to Oxford would consist of persons coming from several different lines to Rugby; and I believe that, as the number of railways extends, it will be quite impossible to send carriages from each line on to the uniting line, to be severed again perhaps into two or three a little further off. The amount of stock required for such a thing would be too enormous, as the railway system extends.

4032. Will not the amount of stock for passenger travelling from the North to Oxford be almost equally

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increased by having a double set of carriages, the Narrow and Broad to meet at Rugby?

Diminish work of stock by sending it too far into other districts.

No. Provided the extent of the line be sufficient to get the fair work out of that stock, you diminish the amount of work that you get from your stock by attempting to extend it too far into other districts. If the Broad Gauge system of railways, south of Rugby, has a sufficiently extensive line under work well to employ their carriages, it certainly will not beneficially employ them to send them sometimes from Rugby on towards one direction to spread off into other branches, sometimes into other directions, where they may not have immediately a return traffic to the south. The

Great Western stock never idle now.

extent of railways even that the Great Western Company have at present, is quite enough to employ to the utmost the stock that we have or that we want, and it need never be an hour idle; and therefore it cannot diminish the proportion of stock required to extend them to others, and I believe it would increase them. If we have a train running from Oxford to Rugby to meet trains running to the north, if that is a part of the system which beneficially employs their stock, there is no advantage in sending the carriages beyond that point. I think there is a limit which many Companies are fast passing of the beneficial employment of stock by attempting to branch into too many.

4033. Does not the system of the clearing-house meet the difficulty of the carriages of one Company running over the line of another?

It cannot meet the difficulty of a carriage arriving at a small station and having nothing to bring back. The

The clearing-house a business-like way of ascertaining where carriages are.

clearing-house system, which has grown into such extraordinary reputation by the discussions of last session, is simply a business-like way of ascertaining where the carriages are, the amount of stock that has run upon different lines, and balancing accounts as to that, but it does not at all render the system an economical one. If you have two or three trains coming to

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Rugby with passengers from different districts, and if the system is to be to send those separate carriages on, whether Narrow or Wide Gauge, you will require more stock than if you ask the passengers to step out from that carriage into another, and pack them off in proportion to the demand; and as railways increase in number I believe that must be the necessary consequence, and that passengers will be forwarded less frequently in the original carriages than they can be and are now, when there are fewer railways.

Sending stock on instead of changing carriages requires more stock.

4034. On the Great Western Railway you change your second-class passengers at one of your stations always?

Yes; on the Oxford branch, on the express trains, we change all the passengers. On our other trains we generally change all the second-class at Didcot, going to Oxford. And that is with our own stock, and for no reason but economy in working the stock. At Swindon we do the same as at Didcot: with our express trains we change all the passengers. With our ordinary trains, we change the second-class, and some of the first class, if there are too many for one carriage; and that is with our own stock, and with every desire to accommodate the public, and to do the best.

Second class passengers changed at Didcot.

Remedies.

4042. Supposing a Break of Gauge to take place at Rugby, how would you propose to arrange for your passengers and goods generally?

Passengers, I suppose, would be treated in the same way that we now treat them at Didcot, which would then become a less important station, and would no longer be, I suppose, an exchange place; the trains and carriages would run directly from London, through Didcot, to Oxford and Rugby: the change would take place at Rugby, just as it does now at Didcot.

4048. Having dealt with the passengers, and having

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had now some considerable time to think of the question of goods, since it was brought forward in the last Session of Parliament, have you made up your mind at all as to the mode in which you would arrange respecting them?

Mode of treating goods must depend on other Companies.

No, because it must depend upon what the other companies choose to do on the other side. If they do not afford assistance, I will not say if they throw impediments in the way, but if they do not afford assistance to exchange, the mode must be different from what it would be if they did.

4050. It would involve, I suppose, a detention of four or five hours, at least by the goods trains?

Oh dear, no; I think nothing of that kind; even two or three hours' detention would not necessarily, nor would it probably, be an increase of two or three hours upon the time occupied between a northern town and a southern town, because from Rugby the goods will consist of goods coming from more than one place and by more than one railway. There are many who can speak more correctly upon these points than I can; but I know the fact, that when a train comes in from Exeter to Bristol, there is a considerable delay from various causes, and pending that delay there is the trans-shipping and repacking of goods going on in our own goods shed, in our own goods train, before it is forwarded towards London. Goods are picked up at the various places between Exeter and Bristol, and then have to be delivered at the various places between Bristol and London, and it is not at all an inconvenient thing half way to re-stow many of those goods.

Delay in any case independent of break of Gauge there. Break no inconvenience.

4051. Supposing that the system of unloading should not be adopted, to which of the other systems should you give the preference?

It would depend entirely upon the extent of the trade, and upon the nature of that trade. If there

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Recommends loose bodies and narrow waggon on broad truck.

were large quantities of goods in bulk, I think the trans-shipping of the body of the waggon would be a very convenient way of doing it; if there were frequently waggons with various goods, and no assistance whatever afforded to us by the other companies, and assuming then that we did not unpack, I think taking waggon and all would be one way that we should adopt.

4052. Upon another truck?

Upon another truck.

4054. Are you inclined to think that the introduction of another pair of rails, or another rail to diminish the Gauge, would be a less objectionable mode on the whole?

No; I should say that on that line it would be more objectionable. I do not think the object to be attained is sufficiently great there to make that the most economical way of doing it.

Loose boxes would not require the alteration of every truck.

4058. If the loose box system were introduced for coals, would it not require the alteration of every coal-waggon now in use?

Oh dear, no.

4060. If evidence has positively been given by gentlemen connected with that line that, from their knowledge of their existing stock, they must alter all their stock, whatever my opinion may be, of course it can only appear as a contradiction of a statement of facts, but I cannot conceive that, in the case of a trade which does not now exist, for the trade in coals from Rugby to Oxford does not exist, and the quantity of coals which is sent to Oxford is at present to my knowledge very small compared with that which I believe would be sent if a railway existed between Rugby and Oxford; knowing all that, and looking forward to the general extension of traffic in coals, or any other com-

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modities, when you open a new line, I feel perfectly convinced in my own mind, that if we throw open the whole of Oxford, Reading, and all other districts between Oxford and Rugby, to the coal-fields which are now worked on those other lines, they must have new waggons to meet the demand.

4072. Suppose the railway system to be extended, so as to include a far greater number of small towns than it does at present, would not the Narrow Gauge have an advantage over the Broad Gauge?

I do not see that it would have any advantage; the difference between the two might be less great, but I do not know what advantage the Narrow Gauge has under any circumstances over the Broad.

4073. Would it not be practicable, for instance, to start single carriages from small towns constructed on the Narrow Gauge, whereas such carriages would be totally useless on the Broad Gauge size?

Expense of Broad carriages and engines scarcely greater than of Narrow.

No; the proportion is as three to four. Now an engine of a given power on the Broad Gauge is not practically more expensive than on the Narrow; the difference is too trifling to be worth mentioning. The cost of a carriage on the Wide Gauge is not more expensive than on the Narrow, therefore it would only be, that if the same length of carriage were used in the one case as in the other, you would be having a carriage certainly capable of holding four people instead of one capable of holding three.

4077. It is understood that many of the Broad Gauge trucks which pick up loads at the small stations on the Bristol and Gloucester Railway are not above half filled; are you aware whether that is the case or not?

I dare say it may be; in fact, if it is so stated, I cannot, of course, have an opinion to put in comparison

with the statement of those who actually conduct the traffic.

4078. Of course, in a case like that, there is an actual loss from the conveyance of a heavier carriage upon the Broad Gauge?

Assuming, of course, that there is a quantity of goods which is not sufficient either for a Broad or for a Narrow Gauge waggon, if you put that into a Wide Gauge waggon there is some proportionate loss in weight. The amount of loss is very small, because the Broad Gauge waggons are not proportionately heavier than the Narrow in proportion to their width, all other things remaining the same.

4099. In what way would you propose to do it, suppose it were to be done by a single line of additional metal?

Sees no difficulty in a double line within the Broad Gauge.

There are two ways, of course; either to put two complete additional rails, which is the best job of the two, or to put only one additional rail. With one additional rail, and the ordinary mode of laying rails upon cross-sleepers, there is no difficulty at all in it. The difficulty is a little increased by the longitudinal timber system, but the two timbers, at two feet apart from centre to centre bolted together, do not offer any material difficulty of construction, and I do not see any difficulty in constructing a line with a five feet and a seven feet Gauge.

4107. Supposing a double line of metal was laid within the Broad Gauge, should you contemplate the running of carriages at different Gauges intermixed in the same train?

No; but if it were necessary it could be done very easily.

4108. You see no particular objection to it?

No; I do not myself think that it would be done, but I do not see any difficulty in it.

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Uniformity of Gauge.

North of London would not propose the Broad Gauge.

4084. If I were projecting a line from London northwards, running through the districts which are now fed by other railways, and depending therefore for my supply upon the traffic brought from those other railways, and assuming, of course, that the length of the line was not enormously great compared with the length of those which fed me, and the distance from London of those which fed me, I should not think of proposing a different Gauge.

4085. Does not the same thing apply to a railway running northwards from Oxford?

No; for this reason, that it is in connection also with Broad Gauge lines southwards, and it then becomes a balance both of the convenience or inconvenience of the Gauge, and of the interest of those who are working the line as to whether it had better be in connexion with the southern line or Broad Gauge line, or with the other. And also allow me to observe that the circumstances are totally different of a line running northwards from London and a line running northwards from Reading we will say. A line running northwards from Reading to Rugby goes to Rugby, there expressly at one single point to collect the traffic of several lines, and to bring it down to distribute it along another line of railway, and I believe, as I said before, that practically there must be an exchange of passengers taking place at those points, whether the Gauge be the same or not; whereas, in the case of a railway going from London to the north, where everything is concentrating at one point, and where the traffic into each of the principal divisions would do doubt be very great, so as to be running specific trains, the mode of working it would be very different.

Reasons why he approves Broad Gauge North of Reading.

4019. In the event of the general adoption of the Atmospheric principle, would there be any reason for constructing it on the Broad Gauge rather than the Narrow?

Yes; I think there would be all the same reasons, or

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nearly all. I do not know whether there would be any new ones brought in.

Opinion on Gauge.

3898. I am perfectly convinced that the idea of bringing all the traffic from all the different lines into one spot in London is a mistaken notion. The number of people who want to go directly through London is not large; most people have some business in London. With respect to goods, I do not think you would find a load of goods in a month going directly on from Bristol to Brighton or from Bristol to Dover.

4037. Do you think that any great public inconvenience would result from bringing the whole of the railways of the kingdom into one uniform Gauge.

I believe most firmly that the public advantage generally would be injured by it. There would be an advantage of course in similarity of Gauge, inasmuch as it would get over any difficulty experienced through changing from one Gauge to another, but, on the other hand, I believe that a great deal of the progress that has been made in railways has arisen from the fair emulation which exists between the promoters either of two Gauges or of other varieties, and that the system of generalizing, whether the Gauge or anything else, would do harm rather than good.

Believes uniformity would destroy healthy emulation between companies.

Economy of working and construction.

3941. I believe the fact is, that our embankments and cuttings are not wider than upon the London and Birmingham. But then, of course, they have the advantage of a greater width outside the rails than we have. Still the difference theoretically is not so great as it might at first appear to be, because part of the difference in the case of the Great Western arises from the circumstance that I not only increased the Gauge of rails, but I increased the width of way which I proposed each system of rail should occupy. Certainly theoretically it ought to affect the thickness of the walls and abutments, but nobody would practically

Cuttings not wider than London and Birmingham, but latter has greater width outside the rails.

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make a difference in the abutments of a bridge whether it were 28 or 32. In a bridge over the railway the wing walls remain the same, and where the bridge carries the railway then the barrel of the bridge only becomes increased. *In tunnels the increase is the most considerable of any of those separate works.*

In Great Western tunnels more expense.

Surface for surface, stations less than Narrow Gauge.

3944. It may appear at first odd, but the fact is, that, taking surface for surface, our stations are less for the same convenience, because the amount of surface covered by our carriages is rather less per passenger; but assuming it the same, the length of our trains, and therefore the length of our platforms, which materially affects the extent of station room, is less than it is with a narrower Gauge in about the proportion of 3 to 4; that is again a little reduced from our system of six-wheeled carriages; but that has nothing to do with the question of Gauge.

Power and construction of engines and carriages.

4008. The bad effect of a curve is aggravated only by the longitudinal distance of the axles from each other. Whether the wheels are five feet apart or seven feet makes no difference in the friction or resistance in going round a curve even at high speeds.

Curves.

4011. Possibly the average amount of slip, if there is any, is more in going round the curve of a Wide than a Narrow Gauge.

4017. Have you practically discovered any practical inconvenience in curves from the width of Gauge?

None whatever.

4080. Does not the Broad Gauge of necessity involve a greater dead weight?

A Broad Gauge waggon proportionally lighter than a Narrow Gauge for the load it carries.

It involves some, but a very trifling increase in dead weight. If you take a Narrow Gauge waggon, cut it in two in the middle, and widen it by putting in a piece between, that waggon will be perfectly fit to run upon the Broad Gauge. A Broad Gauge waggon will be proportionally lighter than a Narrow Gauge waggon for the load it carries.

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4089. I believe there is a diminished cost upon the Great Western; I do not know that it amounts to what I should call much, but I believe there is a diminished cost as compared with the principal Narrow Gauge lines.

4091. Mr. Gooch has given us the relative locomotive cost for the goods trains, on the Great Western .06, and upon the London and Birmingham .12?

Thinks Mr. Gooch has made some mistake in calculation of locomotive cost.

Then I should think there must be some circumstances operating to that result, quite independent of the circumstances of the construction of the two railways: "expenses" is a very vague term—it may include or exclude a great many things, and in comparing one with another you must dive into the details and see what they are.

4094. Your driving wheels are reduced in their diameter very considerably, are they not?

Uses engines from 6 feet to 7 feet in diameter.

No; the original proposal on my part was 7 feet and 8 feet for passenger engines, and the result is, that 7 feet may be considered as our diameter at present, with some of 6 feet, though I am not sure the result of our experience is not to bring it back nearly to the 7 feet and 8 feet. Although I expressed some fear of the feasibility of constructing 10 feet wheels, I thought they were worth a trial. They were made, and it so happened that the three engines to which they were applied totally failed in other respects, and the whole engine was cast aside. Still, although the failure of the engine had nothing to do with the wheels, yet I should not attempt a 10 feet wheel now for an engine.

Speed.

3951. It must be admitted that 60 miles an hour involves some increased danger over 40; but that increased danger is met by increased precautions, and I believe that, all things considered, the express trains are as safe as the others.

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Great Western traffic chiefly between London and Reading, and London and Bristol.

5327. The traffic upon the Great Western, as at present worked, is very unequal, a large proportion being between London and Slough, and London and Reading, and between Bath and Bristol, leaving the rest of the line comparatively very bare of traffic; the consequence is, that it is very difficult to work the whole line as economically as it could be worked if the traffic were equal throughout the country, because many trains that run through from London to Bristol, when they pass the centre part of the line, are comparatively empty. We cannot, therefore, work the whole line so economically as the portion between London and Reading, or as another line which has an equal traffic throughout.

5329. Do you diminish the number of carriages at Reading and leave them behind in order to diminish the weight?

Only occasionally.

5330. So that you are carrying a great amount of useless load?

Yes; on the central part of our line we are working less advantageously than we otherwise should be

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October 21st, 1845.

Mr. SEYMOUR CLARKE, Traffic Superintendent of part of the Great Western Line.

Opinions on Gauge.

3554. Have you at all considered the advantages or disadvantages of the Broad Gauge as compared with the Narrow Gauge?

Knowing how things are done, prefers Broad Gauge.

Yes, I have my own opinion about it; having been so long connected with the Broad Gauge, and knowing how things are done generally upon the Narrow Gauge, and examining calculations and drawing inferences from them, I am strongly impressed with an opinion—it may be a prejudiced one—in favour of the Broad Gauge.

3555. Will you favour the Commissioners with your reasons for coming to that conclusion generally?

I think that in the Wide Gauge lines we have less wear and tear; that we afford greater convenience to the public; that we are able to get stronger carriages, in consequence of having so much more room; to obtain greater speed with less cost, in consequence of the room that is given to the working parts of the engine; and likewise, that we have greater safety.

Safety, Curves, Speed.

3556. Have you any reason to believe that the Narrow Gauge lines are practically unsafe?

No; I should say, practically, that they are safe. But then they do not do what the Broad Gauge line does; they do not travel at such a speed, and with such ease and comfort; and the wear and tear is certainly more on those lines than on ours, I am given to understand.

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3559. Have any evils resulted from the carriages on other lines being lighter?

In any accidents that have occurred, I have always heard of the carriages being much damaged; but in that accident to the express train on the Great Western in which I was, the carriages suffered wonderfully little. General Pasley saw them as they stood after the accident; they travelled by themselves on their own wheels, and I attribute that entirely to the strength of the carriages; and I also attribute the comparatively little injury that was done to the passengers entirely to the strength and size of the carriages. I think if they had been smaller carriages, and less strongly constructed, and there had been less room inside them, people would have been killed instead of being merely hurt.

Thinks on any other line than Great Western passengers would be killed when carriages turn topsy turvy.

3577. When you speak of increased base giving you increased safety, have you ever heard of any carriages being thrown off on account of the base being narrow?

No; but the carriages have great oscillating motion, which would have a great tendency to throw them off.

3578. But it has not thrown them off?

The carriages of the Eastern Counties were thrown off by the oscillating motion.

3579. That was upon a new road?

The new road gave an oscillating motion; but the Narrow Gauge line might be out of repair, and cause the same oscillating motion.

3580. But your engines do get off the line sometimes?

Not from that cause.

Broad engines get off the road sometimes, but not from same cause as Narrow engines.

3581. But they do get off?

They get off at the points.

3592. The width of the Gauge ought to decide and influence the width of cuttings?

They must have room to spare on the Narrow Gauge lines. Our engines would travel perfectly well through the cuttings and tunnels of the Narrow Gauge lines. They have as much space between them as we have. Another line could be laid down at the outside.

3593. If, on a Narrow Gauge line, a certain space beyond the rails is necessary for safety, in your embankment you require a space equal to the difference between 4 feet 8½ inches and 7 feet, in order to give the same amount of safety?

Yes; but we do not find that there is any want of safety with the width we have given.

3594. There are certain northern lines where the edge of the embankment comes up nearly to the line; engineers generally, I believe, think that a defect, because if an engine gets off the line nothing can save it. Mr. Cubitt will tell you that he thinks it tends to the safety of passengers to have a considerable margin of the embankment beyond the rail?

Yes, doubtless it is; we have a margin.

3595. If the same amount of margin is required in both cases, you must have an increased cost of construction?

No doubt in that case there must be an increased cost.

3636. At Didcot and Swindon, is the luggage van carried on with the luggage of the second-class passengers?

There is no difference made between the luggage of

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Break of Gauge. 3637. So that, though the second-class passengers are transferred from one train to another at Didcot and Swindon, the luggage is not transferred?

The luggage is transferred at Didcot, and not at Swindon. At Didcot the branch is short to go to Oxford; but there are a great variety of stations on the branch from Swindon. It goes to Cirencester and Gloucester, &c.

3638. At Didcot the luggage of the first and second class passengers is all transferred from vehicle to vehicle?

Yes, but not at Swindon.

3639. How long a time does that occupy?

No difficulty in changing passengers and luggage at Didcot, except when passengers are numerous. It does not take longer than the time occupied in watering the engine and shifting the train. The trains are broken at the junction; and, with regard to the shifting of the luggage, except on particular occasions, when the men are going to Oxford, or when there is some commemoration which takes people in shoals to Oxford, there is no particular difficulty.

3640. On those occasions do you take a separate luggage-van?

Yes; we have as much as a luggage-van can take, when the men are going down.

3641. So that on extraordinary occasions provision is made for carrying the luggage through?

Yes, without shifting at Didcot.

3642. And of course you look at the power of carrying the whole of the luggage through as an important thing?

The power of carrying luggage through a material advantage. It is a material advantage when there is such a large portion of it.

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3670. Have you at all considered the question of the amount of inconvenience that the public will experience from the break of Gauge taking place?

Yes, I have. I think the public will experience very little. The places where those junctions of the two Gauges would take place would be principal stations; and at principal stations people are always very ready to get out, even if they have to change carriages. If the train stops at a station, the difficulty is to keep the people in, not to get them out.

If a train stops at a station the difficulty is to keep them in, not to get them out.

3671. This is a question applicable to luggage also, because every individual takes some small article into the carriage, and, in having to shift, those small articles have to be shifted also?

Yes, they have; but small articles are so very easily shifted, that they do not present any difficulty.

3672. A whole train of passengers to be moved is very different from the case of a few individuals?

Yes; but we are used to shifting full trains of people. At Swindon and Didcot the second class passengers are all shifted invariably.

Second class passengers shifted at Swindon.

3673. Why do not you shift the first class passengers there?

First class passengers not shifted, because the public do not like the idea of changing carriages.

We do not shift them, because the public would like better, I dare say, the idea of not being shifted.

3674. You give them the preference, in fact?

Yes; but it is mere idea. At Swindon you find all the first class passengers get out to get their refreshment, and they could not tell whether they were getting into the same carriage again or not.

3675. But if they knew that the carriage must be changed, they would be very careful not to go into a fresh

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one till they saw all their luggage and different articles placed in the fresh carriage?

If you saw the way practically in which we do things, and the way that people do neglect their luggage, you would not, I think, hold that out as an argument.

3676. It is because they feel convinced you do not intend to touch the carriage?

I think, practically, we may know there will be trouble to us, but not to the passengers.

3677. Looking at the possibility of the line being made between Oxford and Rugby, where do you think the public would suffer the least inconvenience from the break of Gauge taking place?

Prefers a large station for break of Gauge.

Where there is a large station. It would make very little difference to the public where they were shifted. Rugby is a large stopping station, and it would be no more inconvenient to them to shift the carriage at Rugby than it would at Didcot.

3678. From managing the traffic of the Great Western, should you be disposed to make passengers get out of their carriages and go into others, or should you be disposed to move the passenger and his carriage together?

I should be inclined to move the passengers, because it will come to that; it will come to that even if the Gauge were the same. The railway system is so much increased, that carriages will never run all over England; you will never find carriages going from all those intermediate junctions and places, from the North, from Scotland to Southampton across those intermediate lines; even if the Gauge were the same, passengers would shift: at least that is my opinion; it may be erroneous.*

Thinks carriages will never run all over England.

3679. You confine that remark to passenger carriages for the present?

The question put to me referred to passengers.

* See Mr. Bruyeres' Evidence, p. 155.

3680. Then, assuming that to be the system with regard to passengers, what would be your proposition with regard to luggage; I mean to goods?

I was going to answer the question as far as passengers' luggage was concerned. With regard to goods, I think the better plan would be to shift the load bodily, not piecemeal.

3681. To lift the carriage, the body from its wheels?

Yes.

3682. And transfer that body and its load to other wheels on the other Gauge?

Proposes to lift body to other wheels at change of Gauge.

Yes, either by shifting the carriage and the axles, or by lifting the body from one carriage to another carriage; but that is so much a thing that would be the result of practice, that we should find immediately which was the most beneficial mode.

3683. Do you think that this would be a preferable system to having another rail laid down?

I think where it was practicable to do that it would be a better thing, with luggage certainly (miscellaneous luggage), but I do not think there will be any real disadvantages in shifting heavy loads of minerals, and things of that sort. With miscellaneous luggage I think it would be better, if it were not practicable to lift the body, to have another line.

Additional rail.

3684. Another rail you mean, not another line?

Another rail.

3685. So as to work both Gauges upon the same line?

That would give the Railway Companies the least trouble; I do not think the public would feel it the least in the world; I do not think it is a matter that would affect the public in the slightest.

3686. Would it not?

It would not; and I think it is a thing that has been

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taken up very much, how the public would be affected; I do not think the public would be affected.

3687. That is the great question; the public keep the railways, and the railways are made for the public?

Break would inconvenience railway porters, not the public.

Yes. As far as the public themselves are concerned, according as they shift their own persons they will be inconvenienced or not; but it would be the Railway Companies' porters who would be inconvenienced, if I may use the expression, in shifting the loads one way or the other.

3688. It depends also in some degree upon the hour at which the traffic is proceeding; because if the shift takes place in the night, and in the winter, it is a disagreeable operation?

That is going back to the first question; but upon the second question, with regard to luggage——

3689. I talk of goods, not luggage?

What inconvenience could it be to the public, whether their goods were shifted or not?

3690. It would thus affect the public, that coals might be broken, or things mislaid?

Loose bodies or boxes for minerals.

You will allow me to refer to the answer which I made to that; that in the case of minerals and heavy things, coals and iron, in fact the heavy things which are carried in large masses, I think certainly that experience would teach us, for it comes to that, that the better plan would be to lift the bodies from the carriage, to lift the carriage-bodies from one set of wheels to the other.

3691. But I was endeavouring to ascertain your opinion whether you thought that system would be the best, or whether you would have another rail, bringing in the general convenience of the traveller, and also the convenience of the merchant with his goods;

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because, whatever operation is undergone, it involves a certain degree of expense, and that degree of expense will have to be borne by the consumer; somehow or other the consumer is the sufferer?

Or there would be less profit to the proprietors of the Company.

Does not see that expense or transfer would be borne by the public.

3692. They are more likely to put it the other way?

I really do not see it.

3693. We find that in all other matters the consumer is the person who is the sufferer; and I should think that the railway proprietors are too good merchants to stand alone as an exception to the general rule?

The Great Western Company are indifferent to expense.

I assure you that as a matter of convenience to any part of the public, the expense that it would entail upon our Company is not considered;—if we find out anything wrong, and we can in any way alter it, the expense is not looked at; the convenience to the public is the principal feature, I assure you, in the deliberations.

3694. I have in all cases found it to be so, but this is a great commercial question, not as to the convenience of passengers alone?

But a commercial question carried on by these Companies, and you give them the benefit of that expression which has just fallen from you, certainly it would hold good in a general case when you have applied it in an individual one.

3695. It does not apply to your Company only?

Oh, no.

3696. I mean to say, the question of expense does not apply to your Company alone, because if it be necessary to have the shifting of carriages, it will involve upon every Company sending goods on a Broad Gauge line from a Narrow Gauge line, the

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necessity of the alteration of their carrying stock, I apprehend?

In the present case we are obliged to argue with respect to the Great Western as being the only Broad Gauge line; but as it is probable, I suppose, that many more railways will be made with the Broad Gauge, the disproportion between the number of miles of Broad and Narrow Gauge will become so very much less.

3697. Is it not the fact that the greater the number of Broad Gauge lines which may be interlaced with the Narrow Gauge lines, the greater will be the expense incurred, because it will render some contrivance to meet the difficulty a more universal necessity?

Thinks increase of Broad Gauge lines will decrease the proportion of the evil of break.

Yes; but the disproportion of the number of miles of Wide and Narrow Gauge will not be so great as it is now, if there is more Broad made, of course.

3698. It will not diminish the evil, but extend it?

No; but it would diminish the proportion of the evil, if it is an evil.

3699. It makes it less an evil brought by your Company, clearly?

Yes.

3700. Of course all the coal owners in the North who send coals to Oxford, will have to send them in boxes to be shifted at Rugby?

Yes.

3701. And of course every carriage must be changed?

If that plan were adopted, it would be.

3702. I am very desirous of knowing, taking all these difficulties into consideration, whether you have sufficiently considered the subject to be enabled to

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give a decided preference as regards expense, which is the great subject after all, between an additional rail being laid down, and the change of the carrying stock?

Thinks a third rail more expensive than shifting bodies.

The difference of expense would be certainly more in putting an additional rail, because the comparative cost of the two bodies for the one carriage would be very much less than the additional rail.

3703. Are you giving that as an off-hand opinion, or as the result of calculation which you have gone into?

I think it is very evident.—I am merely answering your question as it occurs.

3704. Are you giving that opinion from having previously considered it, or does it strike you at the moment merely?

I have considered the matter a great deal, we have had the question so much before us; I do not mean to say that that is a question which I expected to be asked; but I have given it a good deal of consideration. Considering the whole thing as a system, I have considered the various bearings.

3705. With your great experience on the line with which you are connected, I should like very much to have your more matured opinion upon the question of the comparative cost, because in some degree the question will hinge upon that?

The question of another line is an engineering question; the question of another body to a carriage, or two bodies to the same set of wheels, is a traffic question.

3706. Which is yours?

Yes; so that I shall not be able to compare the two more than generally.

3707. But you have had so much experience on the

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Great Western line, that the cost of putting down another rail intermediately on your line you will have no difficulty in arriving at?

No doubt I could get at the cost of it by inquiring in the proper quarter, which will be of Mr. Brunel.

Loose-box system.

3708. Have you at all seen anything of the loose-box system upon any line?

On our own line; on the lower parts, it works very well.

3709. At what part of the line is that?

Below Bristol.

3710. Can you mention the stations?

From Highbridge westwards. Highbridge is a depôt where loose boxes are used.

3711. Are coals there put into loose boxes, or other goods?

Coals; it only applies to coals.

3712. They are carried where?

They are carried to Exeter and intermediate stations.*

3713. By what machinery are they lifted up?

By cranes. It is in no sense a complete machinery; it answers the purpose.

3714. Therefore it is a slow operation; at present, it is one which does not require much speed?

Yes, it is a slow operation. It is in the carriage of coals for the supply of the west of England.

3715. Why do you adopt the loose-box system there?

It is not our plan, but that of a Company who work upon our line; they did it for their convenience.

* See Mr. Down's Evidence, p. 296.

3716. Do they ever get their boxes and their carriages separated by that system?

No.

3717. They always go together?

Yes; in fact it works extremely well.*

Thinks the loose box system works well.

3718. But if coals came up from Staffordshire and the Midland Counties, or from Derbyshire for instance to Rugby, would the proprietor of the coals not lose his box and have an empty under-carriage left behind?

It would not be the system, of course; but such a thing might occur. But a business of that sort would become a large business, and be under such control that it is not likely that it would occur as a matter of course that he would lose his boxes; such a thing might occur.

3719. I do not mean to say that he would lose them entirely?

But get them misplaced.

3720. They would be separated the one from the other, and he would then find it necessary to have a double amount of stock?

No, I think not. Even going to trifling details, a great many people now are in the habit of sending their produce from their country-seats. Gentlemen, poultry-merchants, and others; are constantly in the habit of having their empty baskets sent down to be returned full of vegetables from their gardens, and so on. There is no practical inconvenience in it: boxes do not get lost, baskets do not get lost, and I do not see why coal-boxes should be lost or mislaid.

* Mr. Down, p. 296, states that this loose-box system has totally failed, and been abandoned.

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3721. But they are beyond his control; they go upon a different line?

Yes.

3722. And upon a particular line, so that the under-carriage is left without any box to fit it?

I understand your question distinctly, and I answer without hesitation, that if it were the system that was adopted, there would be no kind of chance of any practical difficulty occurring in that respect.*

Projected lines.

3755. The Port Dynllaen will come in contact with no Narrow Gauge line?

No, that is a Broad Gauge district.

3774. In looking at this project, it would appear that a person starting from Southampton would come upon the Broad Gauge at Dorchester, and at a short distance beyond it come upon the Narrow Gauge again?

Where would he be going then, to Exeter?

3775. To Exeter, and on reaching Exeter, and wishing to go to Plymouth, he would have to go upon the Broad Gauge again; so that he would have three different shifts in the journey?

I am not aware how that is; I do not know what the plan intended is at all.

3776. There is a statement laid before us, that it is the

* See the evidence of Mr. Ellis and Mr. Stephenson on the loose-box system.

intention to make it a Narrow Gauge line, and we are aware that the Southampton and Dorchester is to be a Narrow Gauge line; but you have a Broad Gauge line going from Dorchester to Bridport on which that passenger must travel; he must be changed at Dorchester to the Wide Gauge, and he must be changed at a short distance from Bridport to the Narrow Gauge?

There is a Wide Gauge line projected, I think, from Dorchester to Bridport.

3777. There is; and he would have to change the Gauge at that line, and change again at Exeter. All those would be matters of great inconvenience to the public, would they not, four changes in one journey?

Yes; without some good reason.

3801. What have you in contemplation with regard to the mode of working your traffic at the Gloucester station, where the two Gauges come into contact?

We have no plan at present, because, although the two Companies work into the same yard, our station is so very incomplete that there is at present no system of interchange of goods there at all. We have no goods stations. Of course, we are working there on sufferance, in the station belonging to the Bristol and Birmingham Company.

3798. Are you carriers upon your own line?

We are; we carry for carriers too.

3799. Who are the carriers generally employed?

All those who work to the West of England. Chaplin and Horne, Pickford, Parker, Honor, Alexander, Plater, Jennings, and Ford, and a variety of smaller ones. Budd I should have mentioned.

Mr. D. Gooch.

October 17, 1845.

Economy of Working.

Mr. DANIEL GOOCH, Superintendent of Locomotives on the Great Western Railway.

3410. Does the shifting of your passengers in any measure result from your system of placing passengers in particular carriages, confining them to particular carriages, rather than allowing them to spread themselves over the train generally?

No; it results entirely from the wish of reducing the weight of the train. Our trains are now sufficiently heavy for the power, and anything we can save upon that weight is a gain to us.

3431. We have engines that are running consuming only 17, 18, 19 and 20 lbs. of coke a mile; but they are running upon the Cheltenham line, where the trains are not more than 30 tons. That is a proof that the bad gradients do not increase our expenses, provided we have not very heavy trains to contend with; but that is not the average of our total consumption, because sometimes we burn as much as three or four and forty. In regard to the length of the line, I have heard it stated by Mr. Stephenson that economy depends on the length of the line; but I think that if the line is at all sufficiently long to enable the engine to make a fair trip, or a good day's work, without very frequent stoppages (for instance, if you have a line 50 miles long the engine can run out and in) any increase beyond that in no way reduces the expenses, because the expenses which are affected by the length of the line are very trifling. For instance, the repairs depend entirely upon the mileage of the engine, without reference to the length of the line.

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The coke the same, and the cleaning the same. The engineman and firemen's wages also depend upon the distance run.

3461. We have heard here that the Narrow Gauge engines are being constructed as powerful and efficient as the Great Western, because they make the boilers 12, 14, and 15 feet long, and thereby get as much heating surface, as it is called, as we get upon the Great Western; that the fire-box is not the test; that by this enormous increase of tube surface, which in the White Horse of Kent is 17 times the fire-box surface compared with our 7, they are getting what we are getting; and that table (*witness here produced a table*) is to show that neither by calculation nor experiment is that borne out in the least.

3422. You have given in a return the cost of repairs per mile, as 2·7 for the Broad Gauge and 3·46 for the Narrow. Does the diminished cost upon the Broad Gauge result from the system, or from having introduced a greater number of new engines?

From the system entirely. We have a smaller comparative number of engines now working our number of miles than any other railway in the country, and we have not had a new engine for the last three years.

3596. It is the fact that we work the traffic at half the cost per ton of the Narrow Gauge lines.

Convenience of Passengers.

2267. If passengers prefer travelling three abreast rather than four abreast, it would be a reason for the Narrow Gauge rather than the Broad Gauge?

Narrow carriage not so easy as Broad Gauge.

I do not think the Narrow Gauge carriage is so easy as the Broad Gauge, because there is more motion with the Narrow Gauge.

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2268. Is that inconveniently felt, if the road is in good order, and the carriage is in good order?

I have travelled very comfortably in a Narrow Gauge carriage; but, if you take the average working of the Broad Gauge trains and Narrow Gauge trains, I should say that there is more steadiness with the Broad Gauge.

2271. I have often been in the Narrow Gauge carriages when I could not even read.

2272. Has that never happened in the Broad Gauge carriages?

Yes; but I have travelled a good deal on the Narrow Gauge lines, both experimentally and on business, and my own feeling has always been, that the Narrow Gauge is not so easy as the Broad Gauge. I have travelled on the Broad Gauge when it has been very rough.

2273. I never heard a passenger complain of the inconvenience of sitting four abreast, and I believe it is the cheapest way of carrying them; that the more you put abreast the better, as far as the Company is concerned.

Break of Gauge and Remedies.

3375. Having, from the time this inquiry commenced, had full opportunity of considering the question, are you now of opinion that, if the Broad Gauge came up to Rugby, the loose-box system would answer for coals coming from Staffordshire or the midland counties, for Oxford; or what other system would you in preference recommend for the coal trade?

Loose Box System.

I should recommend the loose-box system; I do not see any inconvenience that can attend it.

Recommends loose boxes for coals.

3376. You see no inconvenience in the loose boxes of one Company running upon the frames and

carriages of another Company and leaving those frames and carriages behind? Mr. D. Gooch.

I do not see that there is more difficulty in carrying out that system than in carrying out many of the systems that we have upon the present railways; it is only necessary for a thing to be required, for it to be done.

3387. Do any of those changes take place at night?

Yes; with the second class passengers in the mail.

3388. At Swindon?

Yes, and at Didcot; but if the thing was required to any extent, there would be no difficulty in making a narrow platform between the two trains, and letting the train which arrives draw up exactly opposite to the train that is to start, and letting the people walk out of one into the other. You may change a train of half a mile long in a few minutes if the traffic required it.* Can change a train of half a mile in a few minutes.

2227. In your opinion, does the interval of 4 feet 8½ inches between the rails afford sufficient space for the machinery of a locomotive to work trains on a railway of that Gauge at the highest velocity that would be safe for the carriages and waggons on such a Gauge? Opinion on Gauge.

I think not; you may get a powerful engine into such a Gauge, but it is so cramped that the wear and tear, and the difficulty of cleaning such an engine, would be objectionable. In my opinion, it would better, if you wished to get a powerful engine on the Narrow Gauge, to put an outside cylinder.

2228. Then your opinion is, that by adapting the construction of the engine to that Gauge, the

* See Mr. Wyndham Harding's evidence.

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width is ample to admit of getting an engine of sufficient power to work trains with the 4 feet 8½ inches Gauge at the highest velocity?

Speed.

No, I think not; I think that the Narrow Gauge is not dangerous at a much higher velocity than that at which they run now. I think they might run on the Narrow Gauge more quickly than they do if they had a powerful engine to do it.

2229. Then is there sufficient width in the interval between the 4 feet 8½ inches to give you the power to go at the highest velocity that the Gauge admits of in other respects?

No. I think they might go at a much higher velocity than they do at present, if they had more power in the engine.

Power.

2230. Suppose the Gauge of the carriages and waggons to remain at 4 feet 8½ inches, and it were expedient and convenient to have separate rails laid down for the locomotives, what width of Gauge would you recommend for the locomotives, so as to give the most convenient or necessary amount of power for the traction of the load on the Narrow Gauge lines?

I do not think we have any too much room on the Wide Gauge for the power which we are requiring.

2242. In the Great Western Railway, is advantage taken in the construction of carriages and waggons of the whole width of the Gauge?

Yes, I think it is. We do not overhang our weight more than we can avoid.

Seven feet Gauge most convenient for power.

2276. Then we come to the question of engines, and you think that a 7 feet Gauge is most conve-

nient, as giving you the greatest amount of power?

Yes, I think so.

Construction of Engines.

2295. Will you state what is the speed of the various descriptions of passenger trains, including and excluding the time lost in stopping, and specifying in each case the load, as far as you can do so?

On the Great Western the average trains, excluding the third class, and the quick, are timed to 26½ miles an hour, including stoppages. Of course they are frequently running at 50 miles an hour; 45 is probably their average running speed; but that depends much upon the detentions: if they are long, they are obliged to run more quickly. We can, with 120 tons, do 45 miles an hour.

Great Western Railway constructing engines to exceed 60 miles an hour for 80 tons.

3302. Is it in contemplation to construct on the Great Western Railway, locomotives of greater power for the purpose of obtaining a still higher velocity?

We are constructing engines of greater power, and they will be capable of going at a higher velocity. We can at present do 60 miles an hour with loads of 70 to 80 tons; but the new engines are more powerful than that: and we expect to increase the weight of the trains rather than the speed with them.

3307. What is the ordinary weight of the goods train used on the Great Western and drawn by one engine? what is the maximum weight you give one engine to do?

Two engines sent with more than thirty waggons.

We have a regulation by which, if there are more than 30 loaded waggons, we send two engines. That is, if more than that start at Swindon, because

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there is all that they are to pick up beyond that; but we have had brought into Paddington 84 waggons with one engine. Our largest engines are capable of drawing from 500 to 600 tons from Swindon to London.

Power and Speed.

3411. What is your average weight of passengers per train drawn by one engine, or the average number?

I do not know it exactly. We have brought in as many as 16 or 17 carriages, besides private carriages, well filled by passengers.

3412. With one engine?

With one engine drawn passenger train of 130 tons.

With one engine. We have brought in passenger trains frequently with 120 and 130 tons weight with one engine. We did that very frequently during the summer months. I have an account of some actual trains that were worked. One of our engines brought in 122 tons, a passenger train, and the speed upon that was 45 miles an hour, the highest speed attained. The way in which we got at the speed was this: I was making experiments of the consumption of water and coke.

3413. Was that at Ascot Races?

No, it was an ordinary train. I ascertained the weight for the purpose of making experiments, and this happened to be one of the trains included in those experiments. Another of our engines brought 106 tons in, and attained a speed of 47 miles an hour over part of the line.

3662. Has any amount of speed been mentioned to any of the engine drivers as the speed which they shall not exceed?

No; I think not. I think any speed is considered safe that we have been enabled to reach. They have not been allowed to do it at times, or to make up time on certain parts of the line; for instance, in

the box tunnel and on the Wootton Bassett incline, and two or three parts of the line the speed is limited. Mr. D. Gooch.

3663. Have you any written instructions?

Printed instructions.

3664. Which every engine driver is possessed of?

He signs them before he enters the service, and has them explained to him.

3666. Can all your engine drivers read?

No, they cannot all read; there are one or two that cannot.

Printed Instructions given to Engine Drivers, but they cannot all read.

2291. What is the speed of the goods trains, including stoppages, on each line, and the average load?

Our goods trains are timed to about 15 miles an hour, and the average load of our goods trains has been 312 tons in the last half year.

2292. Are they drawn by one engine generally?

A train of that weight is, but we very often come in with a weight of 500 tons, and then we come in with two engines.

2293. Never more than two?

No, never more. Two engines can draw more than 500 tons.

2294. What is the speed of those engines while running, excluding the time lost in stopping?

They ought not to run more than 20 miles an hour, but that is not always adhered to. The speed is often 30 miles or 35 miles an hour. 20 miles an hour is the regulated speed; but we cannot adhere to it with the delays that take place at the stations.

Mr. C. A. Saunders.

Oct. 22, 1845.

CHARLES ALEXANDER SAUNDERS, Secretary to the Great Western Railway Company.

Break of Gauge.

3847. Are you prepared to admit that there is any evil in there being two Gauges in this country, seeing that there are likely to be frequent junctions of railways of different Gauges?

Break of Guage an inconvenience, not an evil.

There is an inconvenience, but I cannot call it an evil, where two Gauges meet. I believe that inconvenience to be comparatively very trifling indeed, if there is a disposition to obviate it on the part of those who are the managers of the traffic, where the two lines meet.

3850. What inconvenience would your company experience from Rugby to Oxford, if a Narrow Gauge line alone were made?

A break of Gauge at Oxford would compel Great Western to keep double stock, Narrow as well as Broad.

I apprehend we *should be obliged to work two separate and distinct species of stock*. We should be obliged to have a Narrow Gauge stock, as well as a Broad Gauge stock, and it would be attended with expense to us who have our Broad Gauge stock to work; then of course whatever inconvenience there may be attending the change of Gauge would be sustained by our Company.

3854. In the event of a double line being laid down, that is, both for Broad and Narrow Gauge, how should you be disposed to work it?

The Narrow Gauge line would be, I apprehend, for the purpose of bringing the Narrow Gauge waggons only upon the line.

3855. And you would work the trains by Broad Gauge engines?

I should think there is no doubt that that would be

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the mode in which we should work them, if forced to lay down a different rail.

Remedies.

3856. By laying down a third rail, and not by laying down a double rail within the other two?

I think it would be by a third rail, but I doubt whether it would be very much used, and whether there would not be a more economical and better mode of meeting the case without laying it down, than with the additional rail.

3860. Must not an extra stock of loose boxes be created by a change of Gauge?

If parties were averse to loose boxes, coal waggons could be carried on on other low waggons with rails on them.

Not of necessity. Supposing that the parties who are interested in this trade over the line to Oxford are so averse to having loose boxes, or to having any other than their own system and their own waggons, we can take those waggons on to low waggons with rails laid upon them, so that instead of laying down Narrow Gauge rails the whole way for 50 miles, we can have those very trucks in one line with rails laid over them adapted for the waggons to run upon, as if they were running upon the ground with Narrow Gauge rails. We can then have our power of traction applied to those, and carry them away, just as if they were passing over the rails themselves on the ground.

3862. How do you propose to deal with the passengers?

Thinks passengers prefer changing carriages.

I firmly believe that the passengers, upon the whole, would find it more convenient to change the carriage than by any other way; there might be one or two trains in the course of the day in which if there were a considerable number of passengers passing from one particular place to another particular line, carriages could be so planned that they might, in that case, be removed from their wheels, and bodily put on to another line, as they do in France with the diligences, if it were thought desirable. But you find at Rugby, for instance, applying these questions to that case, that there are so

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many lines there converging to and from different places, that the trains scarcely ever carry a number of carriages to go to all those various points; and it would not be an economical way of doing it. For instance, passengers going from Oxford up to Rugby, would have there to be separated, even if there were no change of Gauge: some going to Derby, some going to York, some going to Birmingham, and some going along the Trent valley to Stafford. They could not have four or five different carriages for those passengers to be accommodated to each place.

Impossible to send carriages through from Rugby.

3871. With regard to merchandise, you would propose to adopt one or other of the systems which have been tried at Paddington, either by trans-shipment of the body, or by running them upon low trucks?

I think it would probably come to a transfer of the bodies, but the other plan is quite capable of being done. The transfer of the bodies is perfectly easy: it is done in France: you see several waggons brought in and lifted off their wheels at once, the whole waggon, just as it is, the axle and body, and put on to another truck.

The transfer of bodies the easiest way in the world.

3872. If you adopt the loose box system for coals, would the person supplying the coal-boxes, at or near the collieries, be longer deprived of his boxes, by their being detached from the wheels and the lower carriage,* than if they were fixed?

Not in the least. With regard to goods it is strikingly the case, as it is with regard to passengers, that at those places where many lines converge there must to a great extent be a re-assortment of goods. There is not a sufficient loading of goods for each train, from each manufacturing place going to any one town or place along the line, to devote a whole waggon to these goods.† It is not done even in lines where there is no break of Gauge.

Where many lines converge, there must be a re-assortment; therefore a few trans-shipments more or less cannot signify.

* See Mr. Ellis's evidence on this point.
† See Mr. Evan Jones's evidence.

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3881. Do you state that distinctly as to the practice among the existing railways?

Yes; it was given in evidence that it was so, to a very great extent, at Birmingham. I know that it is so, to a very great extent, upon the Great Western, where there is no break of Gauge.

3883. Are you aware what proportion of goods are so re-assorted?

They would be all packed together and re-assorted; wherever there are goods coming up for those intermediate stations, not being full loads of goods for the intermediate stations.

3893. With respect to the Oxford and Rugby line, have estimates been formed of the expense of making a double line?

There was an estimate formed of the expense of adding a third rail to the other two, and in round numbers, I think it was put down at £130,000; it was said to be about £2500 a mile, making about £130,000 of additional expense.

Opinion on Gauge.

3820. Can you inform the Commissioners what were the great objects of the change of Gauge?

Comparative merits of two systems.

I should perhaps give a very imperfect idea of them in any answer I might give to that question; but, if you will take it in the general way in which I will give it, I would say that the great objects that Mr. Brunel contemplated were these,—to acquire greater power and greater speed; to place the wheels either outside, or as nearly as possible outside, of the waggons, in order that he might enlarge the wheels and diminish the friction; and his belief was that a larger proportionate stowage could be obtained; and that, upon the whole, it would be a decidedly safer and more secure mode of travelling at the high speeds, which he always looked forward to as being likely to be required by the public. He thought that the speed of that day was

Broad Gauge designed to obtain greater power and speed; to place wheels outside waggons; to enlarge wheels, diminish friction; safety.

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one which would afterwards be thought slow. Those were his main objects.

3821. Is it your opinion that those objects have been attained?

I firmly believe that they have been attained in a very high degree.

Speed, Safety.

3822. And, from your present experience, are you disposed to conclude that if the thing were to be done over again, you would adopt the Broad and not the Narrow Gauge?

I think, unquestionably, if it were left to me I certainly should.

3823. You have increased speed and increased safety?

Convinced Broad Gauge swifter.

I think we have increased speed in proportion to the weight we carry, and decidedly increased safety. I cannot think that there is a doubt upon the subject, as far as my experience goes. I do not pretend to mechanical knowledge, or any engineering skill; I merely speak as one who has had a great deal to do with the working of railways; and, from the comparison I have made, I am convinced that upon the Broad Gauge we can carry greater loads at a much higher speed than they can carry upon the Narrow Gauge.

3824. As the secretary of the Company, you frequently travel upon the line?

Yes; and I have the general management of the working of the whole line, and there is no subject that has not been, in some way or other, brought under my consideration, and, through me, brought before the Directors.

3825. Are you aware whether there is greater or less economy in the working of the locomotive power upon your line than upon the Narrow Gauge lines?

Thinks it more economical.

I am led to believe that there is greater economy in

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the mode of working our line. I acquire that knowledge by seeing the returns which have been made by other railway companies, which have been put into a tabular shape and shown me, and by a very close inspection of our own accounts; but I have had no opportunity of going into the books of other companies to investigate them closely.

Economy of working.

3829. The question rather had reference to the construction of the line?

The expense of the construction of the line is certainly greater, but it is not so much greater as might be supposed.

Uniformity.

3849. Is the Great Western Company under any engagement to lay down the Narrow as well as the Broad Gauge from Oxford to Rugby at the cost of that Company?

Bound by Act to lay down Broad Gauge if required.

There is a clause in the Act of Parliament which says, that if the Board of Trade shall require it upon the recommendation of the Gauge Commissioners, it is to be laid upon the Narrow Gauge as well as the Broad.

3859. I question, if the object be to have a Narrow Gauge, whether it might not be as well worked by somebody else instead of by the Great Western Company, and let it take its chance of having very little traffic to carry over it.

3868. Assuming that the Legislature should require you to make a Narrow Gauge railway only, from Rugby to Oxford, and supposing passengers to arrive by any train from the four or five different points you have mentioned, would it not be optional for the Great Western Company to say, We will take these passengers from those four or five different points, but we will put them into one carriage; and even though you had a Narrow

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Gauge line to come to Rugby, could not you compel passengers to take one carriage for the whole?

More convenient to compel passengers to change carriages.

I have no doubt we could compel them, and it would be found more convenient and the better plan to do so, because the other companies could not, upon those long lines from York, Liverpool, and other places, devote a whole carriage to the passengers coming from York or Liverpool to go over the Oxford line.

3877. Suppose a person starting from Southampton to go to Exeter, and thence to Plymouth, he would go upon the Narrow Gauge to Dorchester, where there would be a break; he would then have the Broad Gauge to near Bridport; then he would have the Narrow Gauge to Exeter, and then the Broad Gauge to Plymouth?

List of Broad Gauge lines proposed on the Wilts, Somerset, and Dorset.

Supposing it to be the Narrow Gauge between Exeter and Bridport. The Great Western Company, however, propose to carry on a line from Hungerford to Westbury, to join there the Wilts, Somerset, and Weymouth Railway, for which a Bill is already passed to Yeovil; they are engaged, also, in forming a system of railways between Bridport, Yeovil, and Exeter, in continuation of the Wilts, Somerset, and Weymouth line, in order to afford the most direct Broad Gauge communication throughout from London to the south-west of England.

3902. In your second Act of Parliament there is special power for the circulation of carriages upon different railways, in these words:—"And whereas it would tend much to the convenience of the public if Railway Companies were empowered to enter into mutual arrangements, so as to avoid the necessity of a change of carriages, and other delays, arising from a diversity of interests: Be it therefore enacted," and so on; and then there are provisions enabling companies to make arrangements?

I think that is a general clause in almost all acts.

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Projects.

3907. The Railway the London and Birmingham have proposed from Harrow, to come near to Uxbridge, and thence by Aylesbury and Bicester to Banbury, then to cut across the Oxford and Rugby line, and to reach Warwick and Leamington, and again to enter the Birmingham line at Hampton; together with another line to pass from Warwick, and to cut against the Oxford, Worcester, and Wolverhampton, towards Cheltenham; and the effort that is making by the Midland Counties Company to force the Broad Gauge off from Gloucester to Bristol, warns us that, in order to give fair play to the traffic, and to give to the public traffic the opportunity of coming down from the north in the direction of those lines sanctioned by Parliament, we must carry a Broad Gauge line up in the direction of Birmingham from the Oxford and Rugby, and that we must have the Broad Gauge also by Gloucester to Worcester, and from Worcester to Hereford, there joining the Monmouth and Hereford Railway, as the only means of giving to the traffic the facility of moving along those various lines which have been named. For these objects, a line is proposed from the Oxford and Worcester to Cheltenham and Gloucester.

Projects of the Great Western Company

3908. The Oxford and Worcester line is intended to be prolonged to Port Dynllaen; it will afford great convenience to Ireland and North Wales, and to whatever traffic may have to come down southward along the Broad Gauge continuously, without any change.

3909. Will you describe what is the district which you think ought fairly to be appropriated to the Broad Gauge, taking great lines for demarkation?

Thinks the Great Western should occupy the country south of Birmingham.

I think myself, for the good of the country, that the Broad Gauge ought to occupy the country south of Birmingham in this direction—south of Shrewsbury, and up to the Grand Junction, and those other lines; that it need not go up to the north beyond that line of demarkation. There is no desire, on behalf of the Great Western, that it should go up farther to the north of England; but at present the greater part of

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the traffic from the manufacturing districts in the north concentrates at Birmingham. If those manufactures are to be sent on to Plymouth, to Weymouth, to Bristol, or to any of the southern parts of the country, if the Broad Gauge were made from Birmingham down, there would be no Break of Gauge anywhere; and so with respect to the minerals of South Wales, which might be carried without any break of Gauge to Birmingham and the neighbourhood where the manufactures are carried on, and from Birmingham any heavy goods might be sent down to the south upon the Broad, or sent up to the north upon the Narrow Gauge. I believe a division of that sort would make the best arrangement that the whole question is susceptible of.

3910. But speaking of them as main arterial lines, I think that all south of Chester, of Shrewsbury, and Wolverhampton, ought to be on the Broad Gauge, and to the north of the Grand Junction line on the Narrow Gauge.

3813. Are you aware whether, when the Great Western line was first projected, it was intended to have a 7 feet Gauge?

History of Gauge.

I think not at the original formation of the Company. The question of the Gauge was brought forward by Mr. Brunel to the Directors subsequently to the passing of the Act, but the fact that he would recommend a change of Gauge I became very early acquainted with.

3818. In those bills which were passed antecedently to the Great Western, the question of Gauge was fixed by Parliament; in the Great Western it was not fixed?

There was a clause in the former Acts of Parliament, generally I think fixing the Gauge. I am not certain whether the Great Western was the first Bill in which it was omitted; but it was omitted in the Great Western Bill, and I think that must have been the first Bill in which that clause was omitted.

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